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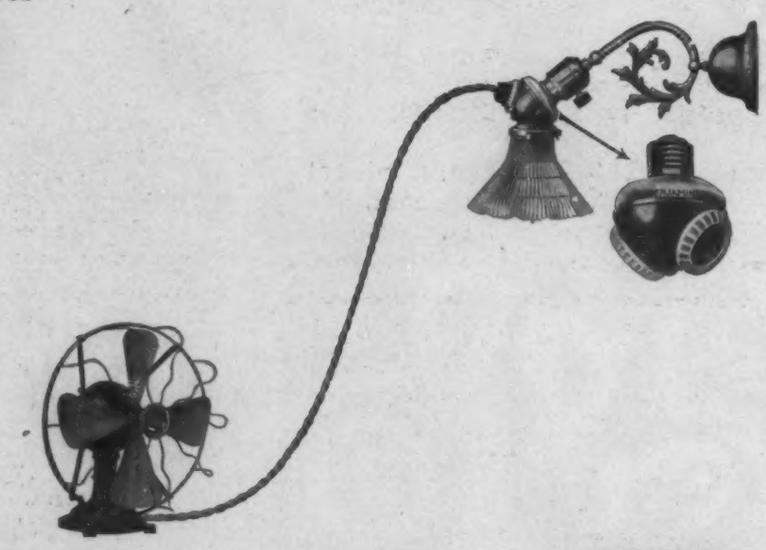

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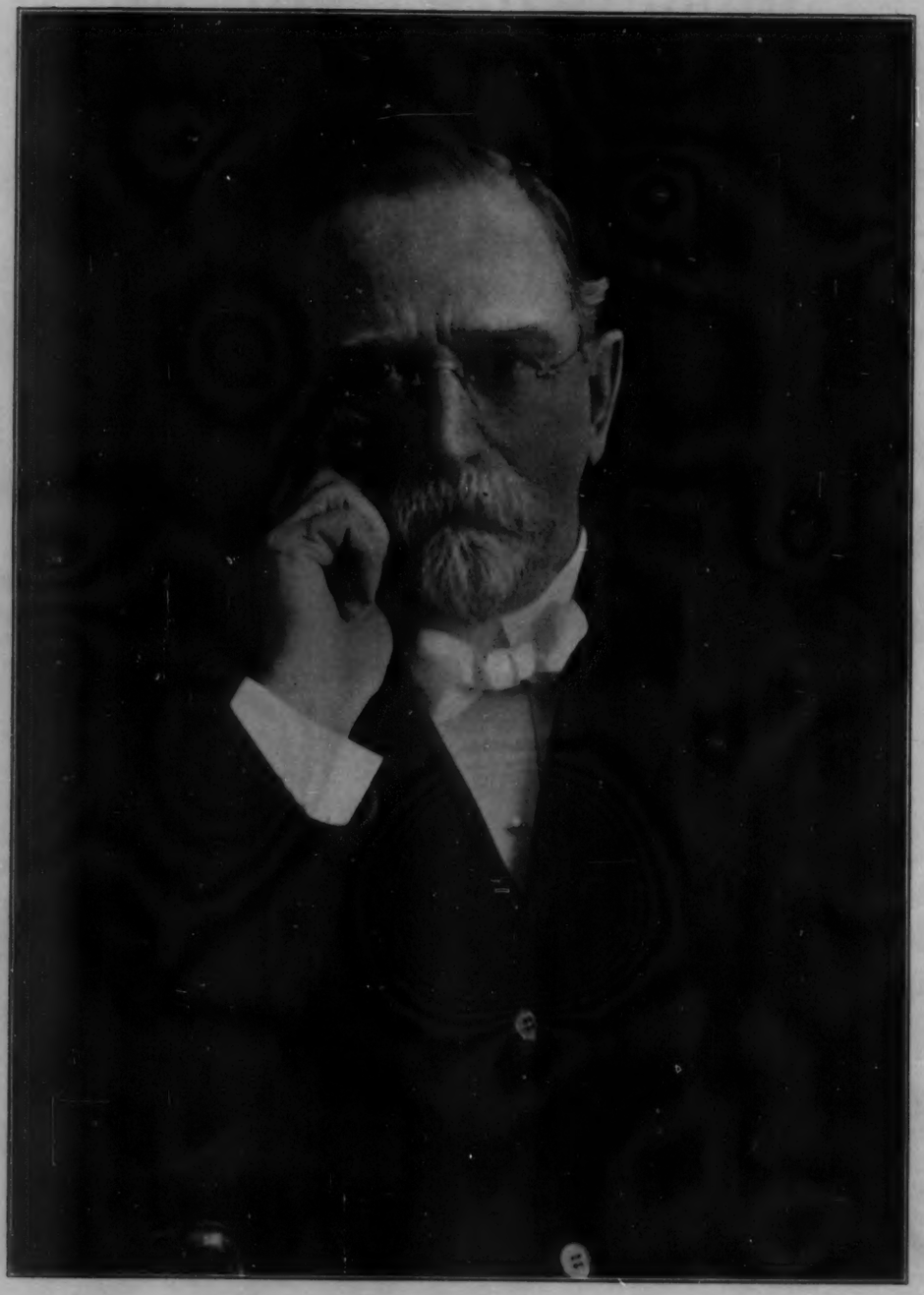

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JOURNAL OF ELECTRICITY

POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy

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MT. LASSEN

NORTHERN CALIFORNIA POWER COMPANY,

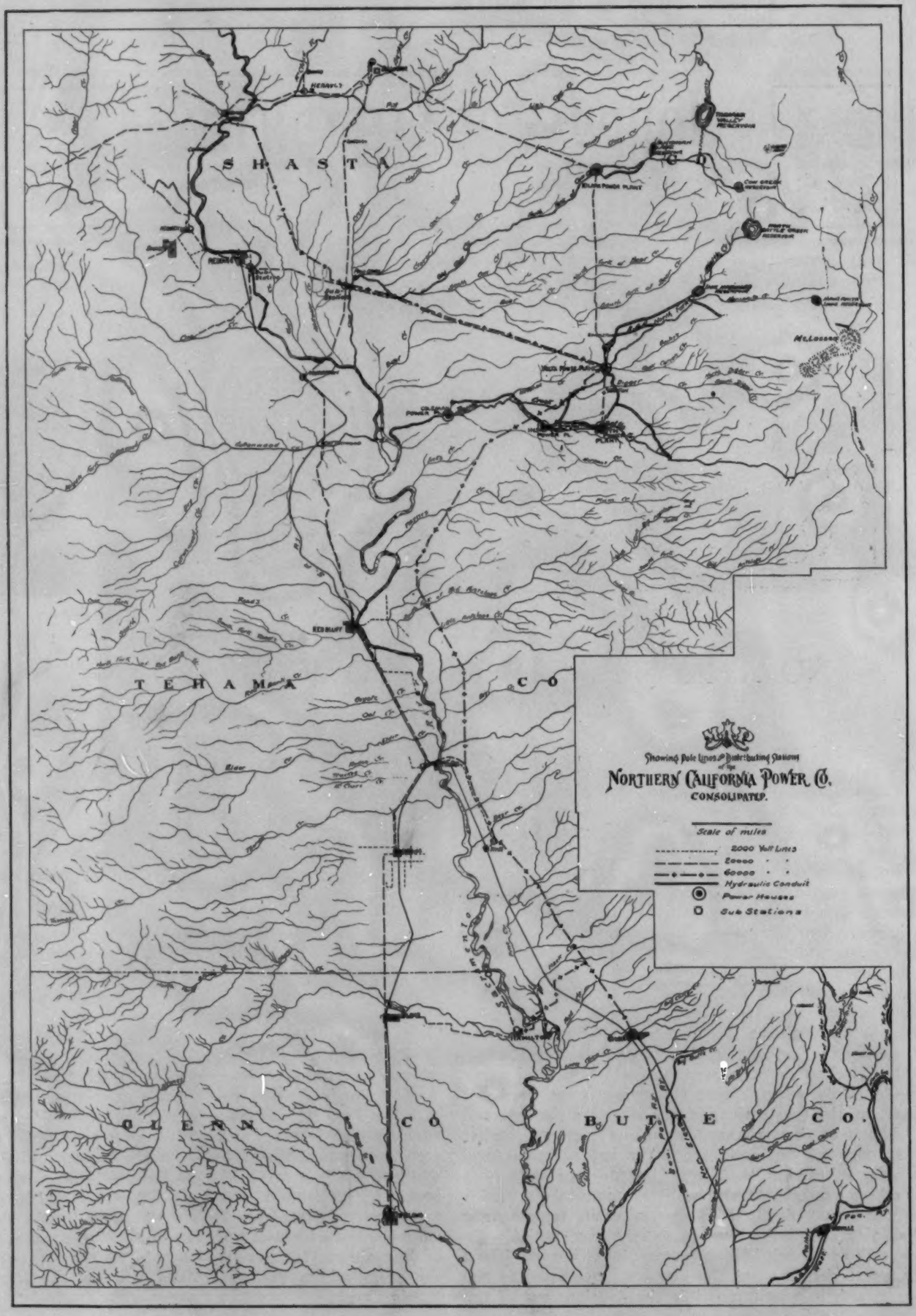
CONSOLIDATED

By Rudolph W. Van Norden

Mt. Lassen in his splendor, isolated from other lesser peaks, stands alone, proudly raising his battered crest like a wounded warrior, who, crushed but undefeated, is monarch of all he surveys. In the dim distance to the north, it is true, his brother peak, Mt. Shasta, higher and more perfect in outline, looms like a white cloud on the horizon; each is a king crowning his own vast domain. We are told, however, by geologists that Mt. Lassen was the highest peak of the Sierra Nevada range many ages ago when it was an active volcano. And that at one time, when the fury of its internal fires grew beyond the bounds of reason for well regulated volcanoes, it proceeded to blow itself up and scattered several thousand feet of its then symmetrical cone over the face of the land. One could easily imagine that this might have been the case, as the two main peaks, Lassen on the left and Brokeoff on the right, appear to be the edges of what was once a giant cone, while the jagged buttes and minarets between them may be the wreckage of a seething crater. At any rate the mountain is still a volcano, very docile, it is true, after its tempestuous behavior, but exhibiting many signs of activity by geysers and much boiling water. That it spread lava to great depths over the country, especially to the westward, has made possible the development of the power system about to be described. For this lava, with its load of cemented gravels and ash, by its porosity, forms a gigantic natural reservoir to conserve the melting snows and supply through thousands of springs of large volume much of the water for this system.

It has long been known that rivers and creeks having their source in the slopes of Mt. Lassen did not behave like most Sierra Nevada streams, whose flow dwindles to a mere fraction of their average during the fall months. The minimum flow of these streams is a high percentage of the average.

There have been for many years a number of small ditches taking their supply from North Battle creek or tributary streams or from springs, which have been used to conduct water to sawmills and in particular to a box factory near Shingletown, on a small feeder running into North Battle creek, known as Millseat creek. It was the use of these early ditches and the water so easily obtained that in the year 1900 was the source of inspiration to Mr. H. H. Noble and associates, to complete the use of this water by the development of a hydroelectric power plant, using a more or less abrupt fall between the old box factory and the point where the water was returned to North Battle Creek.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Funds for the preliminary work were provided and water rights in Millseat Creek were purchased, together with several short feeders deriving their source of supply from springs. A water right in North Battle Creek was acquired and a ditch having a carrying capacity of 3000 miners inches, or 75 second feet, and 2½ miles long was next built. This was known as the Keswick ditch and discharged its contents into Millseat Creek.

There was at the same time a ditch with a carrying capacity of 5000 miners' inches built, which carried all of the accumulated flow of Millseat Creek a distance of one-half mile and emptied it into a forebay reservoir, later named Lake Nora.

This was the beginning of the first plant, and the company was known as the Keswick Electric Power Company.

Later, as the plant was enlarged, other ditches were acquired. One picks up the flow of Bailey Creek on the western slope of Mt. Lassen, and after a distance of two miles, crosses North Battle Creek on a timber flume and trestle and joins the main ditch from Lake Macomber, a storage reservoir in North Battle Creek; it carries 1500 miners inches of water, but the main ditch has a capacity of 2000 miners' inches and the added distance from the junction to Millseat creek, into which the flow is discharged, is 6½ miles. Another ditch, known as the Battle Creek Ditch Company's ditch, also diverts water from North Battle Creek. The company has a majority ownership in this ditch and out of a total flow of 1640 miners' inches, receives somewhat over one-half, which, like the other sources is delivered into Millseat Creek.

From the beginning in 1900 to the present the growth and development of what has now become the Northern California Power Company Consolidated, has been by leaps and bounds. But the successful rise of what appeared to many at first to be an undertaking of great risk, with the possibility for the development of business a very uncertain quantity, has been due to the absolute faith, the minutest attention to every detail, both physical and commercial, a thorough knowledge of prevailing conditions and invincible pluck of one man, Mr. H. H. Noble.

Almost every hydroelectric plant, in California at least, has had little or no load in sight when it was proposed to build the plant, the promoters depending largely on the demand which the future would bring. Yet there is hardly a case where, when the plant was completed and placed in operation, the business did not appear almost as fast as it could be handled, and in many plants the history of their operation has been one of continuous overloads. With the Northern California Company, there was a big sparsely populated territory available; that it had potential values in its deposits of copper and iron ore was known, but outside of a small amount of power to be sold to mines and a considerable electric lighting possibility, there was little industrial development which would form a market for power. Lines were first built to a number of towns; small lighting companies at Redding, Red Bluff and Tehama were acquired on an equitable basis, and a contract to supply power to the smelter and mine of the Mountain Copper Company at Keswick was entered into; power was offered at reasonable rates, and then happened just what the foresight of the founders of this project had believed would come to pass; the industries were attracted by the chance to get cheap power and capital was invested in vast amounts to develop from the natural resources the metals which are in constant demand by the human race—gold, copper and iron.

The smelting of iron ore was, however, not seriously considered, due to the high cost of fuel in this section. It then remained for Mr. H. H. Noble, looking forward to future load possibilities, to introduce a most daring project, the smelting of iron ores by the aid of electricity. This enterprise which will mean much toward the development of the iron and steel industry for the Pacific Coast, he has grappled single handed, experimenting through a long period to final commercial success in the smelters of the Noble Electric Steel Company at Heroult on the Pitt.

The transmission network grew by additions, new lines and enlargements; smelters, quartz mines, copper mines, industrial railroads, pumping plants and factories, were added to the load until a territory 100 miles long and 50 miles wide is now covered. But this growth of load meant more power to be developed; as fast as new machines were added they were

Tamarack Valley.

Site for dam, Tamarack Valley Reservoir. Lower end of valley in the background.

loaded and still other sources of power became imperative. This has resulted in the succession of plants, using much of the same water over and over again, which are described in the following pages.

Watershed and Storage.

There are three distinct watersheds, the first, which is the largest, is also the most prolific, not alone from its size but because of the remarkable underground storage. This is the watershed of Battle Creek and the small streams which lie between the two main branches. The principal source of supply is the western slope of Mt. Lassen and the area drained is about 337 square miles. The second watershed is that of Old Cow Creek and covers an area of 37 square miles. Unlike the Battle Creek watershed, there is little or no underground supply, the result being that this creek acts like most California streams, in that the flow throughout the summer and fall months is but a very small proportion of its volume during the rainy months, then again the greatest altitude is but 8000 ft., while that of the first named is over 10,000, and the area while heavily timbered is much smaller.

The third watershed is that of Burney Creek, which discharges its flow into the Pit River. This watershed is also small and is adjacent in position and similar in production to the Cow Creek watershed. It has an area of about 20 square miles.

Burney Creek would be of little value to a power plant, as the low-water flow is insignificant and the fall per mile is small. But this latter feature fortunately is exaggerated, at least in the district known as Tamarack Valley, and makes possible an enormous reservoir. Between Tamarack Valley and Cow Creek is a ridge, so low, that if the former were less than 100 ft. higher in altitude, water would flow over the ridge. The valley is oval in shape, two miles long and a mile and one-half wide, flat as a table top, but with a narrow outlet making a good dam site. This reservoir, when flooded to a depth of 35 ft., will cover 1540 acres and there will be impounded 29,500 acre-feet of water or 1,285,020,000 cu ft.

It is proposed to drive a tunnel 6990 ft. long from the upper or southwesterly side of the reservoir, under the low ridge already mentioned and thereby carry the stored water into Cow Creek.

This storage is ample to supply all of the water necessary to operate the Kilarc plant, after an additional installation of 3000 kw. is made, over any low-water period of which there is a record.

The Burney Creek watershed is therefore to be used only in conjunction with and as supplementary to Old Cow Creek.

The dam for Tamarack Valley will be a hydraulic-fill earth structure with a concrete core; it will have a length on the crest of 900 ft., a total height of 35 ft. and a width at the base of 106 ft.

Delivering its flow from the north into Cow Creek is another storage reservoir, Buckhorn Lake. This was originally a natural lake and seems to have been an ancient crater; its level was raised by a timber crib-dam and when full has a useful content of 320 acre-feet and covers an area of 20 acres. It is very prettily situated between rugged hills and is surrounded by a dense forest.

There are at present two storage reservoirs in the North Battle Creek watershed. The oldest, Manzanita Lake, at an altitude of 5800 ft., is in one of the feeders to the south; it nestles on the slope of Mt. Lassen, a crystal gem in a wilderness of surpassing

Excavating for Tamarack Valley Dam.

beauty and grandeur. This was originally a natural lake, but a storage capacity of about 1400 acre-feet has been created through the building of a timber dam.

Lake Macomber was originally a meadow through which North Battle Creek flowed. An earth and dry rock dam and embankment was built here at a comparatively low cost and a storage capacity of 2300

Manzanita Lake and Lassen Peak.

acre-feet was thus acquired. Before this reservoir was made, there was much conjecture as to whether it would hold water, the volcanic, porous nature of the underlying rock and the resulting possibility of leakage being a problem which caused some hesitancy in proceeding with the work. The reservoir was however built, and, as predicted, it leaks slowly. But this is a blessing in disguise, as it only tends to add more water to the underground supply, making new springs and the old ones a little larger and a little more constant, but all eventually finding its way into the ditches of the system.

All of the ditches empty into Millseat Creek, from which the flow is diverted into Lakes Nora and Grace, the forebay reservoirs for the Volta plant.

The use of the water after passing Volta is described further on in this article, together with the ditches and other features. The constant increase in the demand for power has, however, made the normal supply inadequate and there is being now constructed at the headwaters of North Battle Creek a large storage reservoir to conserve the stormwaters. This site is at an elevation of 6700 ft. above sea level and the outlet narrows to a gorge, making a good site for a dam. Work on this dam under the supervision of Mr. Emmet W. Sutcliffe, an engineer of many years' experience in Pacific Coast power plant practice, was commenced in the summer of 1909, following designs which were carefully worked out by Mr. Sutcliffe after a study of the particular conditions to be met with at this altitude.

The dam is to be a dry wall, rock-fill structure with a facing on the up-stream side of concrete, varying in thickness from 3 ft. at the crest to 7 ft. at the heel. The profile has a gravity section, although the crest is wider than would otherwise be necessary, were it not for the precautions which must be taken in encountering heavy snow and ice jams against the crest. Originally it was proposed to carry this dam to a height of 60 ft., but eventually the plan was changed and the base made wider to give an ultimate height of 100 ft. above the original bedrock surface which was taken as a datum line from which to work.

There is a curious bedrock condition in this gulch, the bottom and the south side is a hard and homogeneous lava, while the north bank is disintegrating syenite; the latter is not considered of a good enough

Lake Macomber. (1) View of Lake, Latour Butte in background. (2) Dam, showing Waste Wier and Fish Ladder.

quality to be placed in the dam. The lava is therefore being used entirely and a large quarry has been opened in the south bank directly behind the dam.

Site of the Battle Creek Storage Reservoir, headwaters of North Battle Creek; Mt. Lassen in the distance.

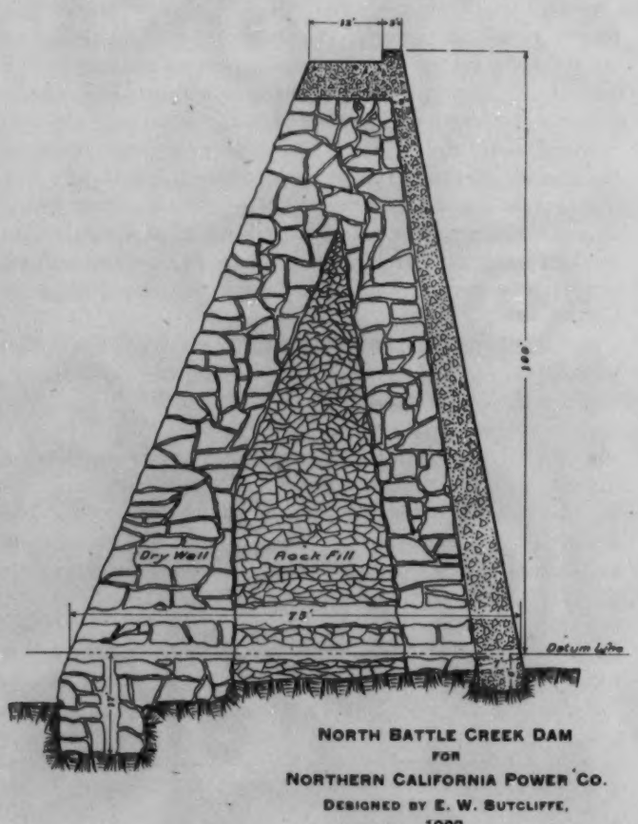
the work. Fuel for the hoisting engines is cut from timber close by and the amount used so far, for engines and camp, has been 3200 cords. The cost, as given by Mr. Sutcliffe, covering surveys, preliminary work, camp, bunkhouse, shop, hoist and compressor and quarrying and placing of stone has amounted to $22,000, or a total cost of $4.40 per cu. yd. of stone in place. The completed dam will have a length on the crest of 658 ft. and a cubic content of 56,000 cu. yd.;

Partially Built Dam for Battle Creek Storage Reservoir.

of this there will be 7000 yd. of concrete in the base, back face and crest. The reservoir formed will have a capacity of 14,800 acre-feet, or 189,000,000 cu. ft.; the area covered will be 600 acres, and the area of the watershed tributary to this reservoir is seven square miles.

Volta Power House.

It would seem that Nature, in her arrangement of things, had anticipated the use of her mountain streams to assist in the extraction of the metals from the ores which she had conveniently buried, not so far away. It would be difficult to find anywhere a site for a hydroelectric plant more perfectly arranged than the one on which the Volta plant is placed.



NORTH BATTLE CREEK DAM
FOR
NORTHERN CALIFORNIA POWER CO.
DESIGNED BY E. W. SUTCLIFFE,
1909

To the north of North Battle Creek is a ridge, set somewhat back from the creek, but paralleling it. The top of this ridge is wide and forms a sort of plateau, which extends with a gentle slope to the headwaters of North Battle Creek. It is this plateau, with an underlying porous lava formation, that forms

There had been excavated from the quarry, up to June, 1910, 8500 cu. yd. of rock. Of this amount 3500 yd. were discarded and 5000 yd. has gone into

the great underground reservoir fed by the melting snows of Mt. Lassen.

Near the edge of this ridge, above the power house, are the two forebay reservoirs, Lake Nora and Lake Grace, and each delivers its contents into its individual pipe line. These reservoirs were originally pasture meadows, and their creation was a simple matter of building low earthen embankments on two sides.

The Volta plant was built in 1901, operation commencing in October of that year. The plant as originally designed was to contain three 750 kw. generators, although but two were installed at first. Lake Nora was built at this time and was supplied largely from springs through a number of small ditches. The question of a Fall shortage of water, so vital to many other power systems in California, did not enter here; the great underground reservoir is always faithful and knows no seasons.

In 1906, when the Volta plant was enlarged to its present size, a second pipe line was installed and Lake Grace was built to supply it . This reservoir is some 2,000 ft. to the rear of the first one and the two pipe lines form, when viewed from a distance, an enormous letter V, the initial of the name of the plant. The country people thereabouts insist that this coincidence was premeditated, but the company says that this is but one of the many proofs that nature intended to have a plant in this spot. At any rate it is a pretty conceit and a good advertisement.

Surrounding the reservoirs and stretching away to the high mountains is a magnificent forest of pine and fir. To the east Mt. Lassen raises its jagged and snow covered summit; to the south and west one has an unobstructed birds-eye view over five counties, one of the most extensive and beautiful to be found in California.

Lake Nora has an area of five acres, while that of Lake Grace is 8.43 acres. Each has a timber forebay containing a set of grizzlies and a double set of fine wire-mesh screens, both placed on a slant to facilitate cleaning any floating debris which may accumulate on them.

From the edge of the ridge to the power house is a fall of about 1,200 ft. The grade is fairly uniform and, while too steep to ride a horse down comfortably, is an ideal grade for a pressure pipe.

The older pipe has a length of 6,200 ft., and the head on the pipe is 1,196 ft. Beginning with the reservoir there is 1,000 ft. of wood stave pipe, 36 in. diameter. The remainder is riveted and lap-welded steel, all 30 in. diameter and varying in thickness from ¼ to ¾ in.

The new pipe has a length of 8,400 ft., while the head is 1,254 ft. The first 3,000 ft. is of wood-stave construction, 48 in. inside diameter. The remainder is part riveted and part lap-welded, the diameters varying from the upper end of 36 in. and a thickness of ¼ in., to the lower end with a diameter of 24 in. and a thickness of 11-16 in.

Through a connection in the power house, explained further on, the two pipes are operated together. An interesting hydraulic paradox thus exists, the head on one pipe being more than 50 ft. greater than that of the other, yet they equalize, due to the relatively high friction losses, as perfectly as a well mated team of horses.

(1) Lake Grace. (2) Wood Stave Section of Pressure Pipe from Lake Grace to Volta Power House.

The power house is placed at the foot of the slope, where the country spreads out in a more or less level manner. There is an abundance of room for all buildings and out-buildings.

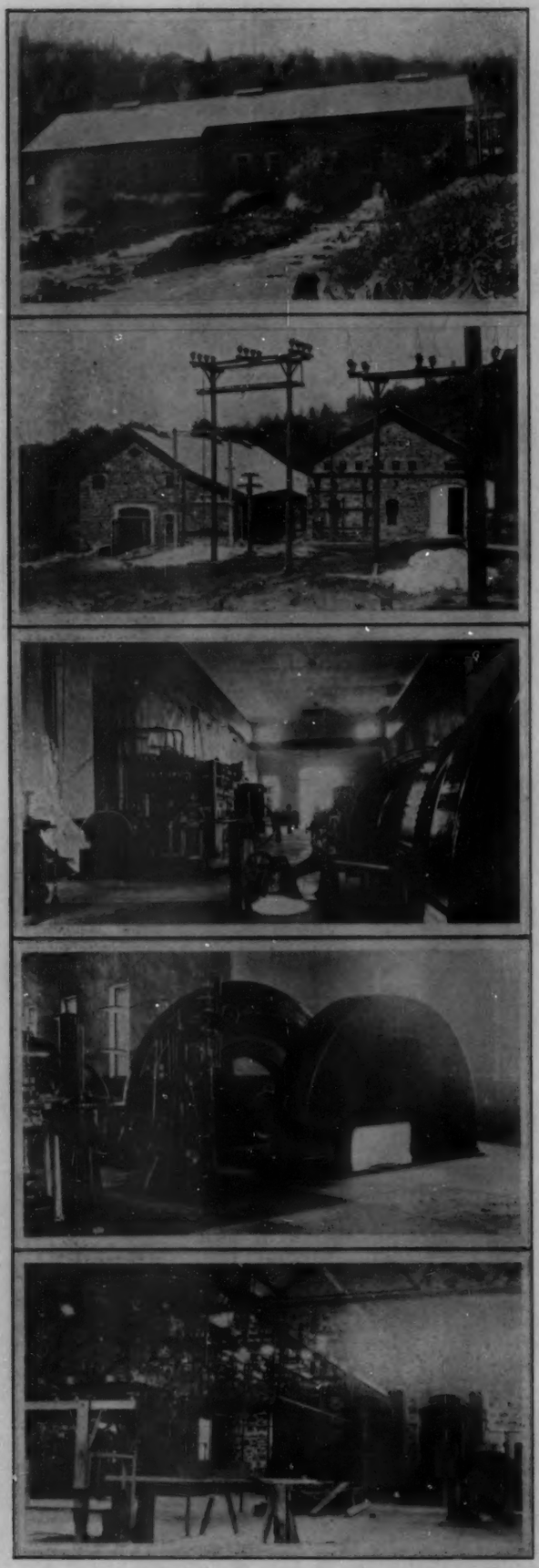
Originally the power house building was 30 ft. wide and 75 ft. long within the main part. It contained three generating units. Parallel to the main part and to the rear of it was a room, 15 ft. wide, in which was placed the transformers.

In 1906 the building was lengthened on its west end, to accommodate a fourth generating unit of 2,000 kw. capacity; this addition being necessarily 10 ft. wider than the older part, due to the increased size of the machinery.

In 1908 the fifth unit of 2,400 kw. capacity was added. The transformer compartment was also extended to provide for additional transformers. In 1906 a separate switch-house, 50 ft. wide and 75 ft. long was erected directly in the rear of the main building.

Both the power house and switch house have heavy rubble-masonry walls, two ft. thick, a type of construction which has been adopted by this company as standard for all of its power houses. The roofs are of galvanized corrugated iron, supported on timber trusses. In the power house a corrugated iron ceiling is suspended from the lower chord of the roof trusses for protection from the danger of fire and also for the sake of appearance.

There is a machine and forge shop conveniently situated a short distance from the power house and beyond this is the dormitory and superintendent's cottage, the former being a comfortable frame structure for the operators of the plant.



Volta Power House. (1) Front view, showing discharge from water-wheels. (2) View of Power House, Switch House and Pole-Top Disconnecting Switches. (3) No. 4 Generating Unit, 2000kw. (5) Interior of Switch House.

The first three generating units have a rating of 750 kw. each. The generators are three phase, of the revolving armature type, operating at a speed of 300 r.p.m. and delivering current with an e.m.f. of 500 volts. The frames and bases with pedestals and bearings are self-contained. These machines have been particularly reliable in their eight years of practically constant operation. They carry overloads most of the time.

The water wheels consist in each case of a single runner on which are mounted cast-steel buckets within a cast-iron case. They are of the tangential type, as are all of the water wheels of this system, so far installed. The shaft is supported in two bearings, similar in type and appearance to those of the generator. The shaft terminates in a heavy cast-iron flange, as does also the generator shaft. Between these flanges is a rawhide-link coupling.

The nozzles are of the deflecting type, operated by type F Lombard governors. The nozzle tips are of the plain or straight variety. Water is supplied from a transverse header placed parallel to and in the rear of the building. The older pipe feeds this header at its middle point.

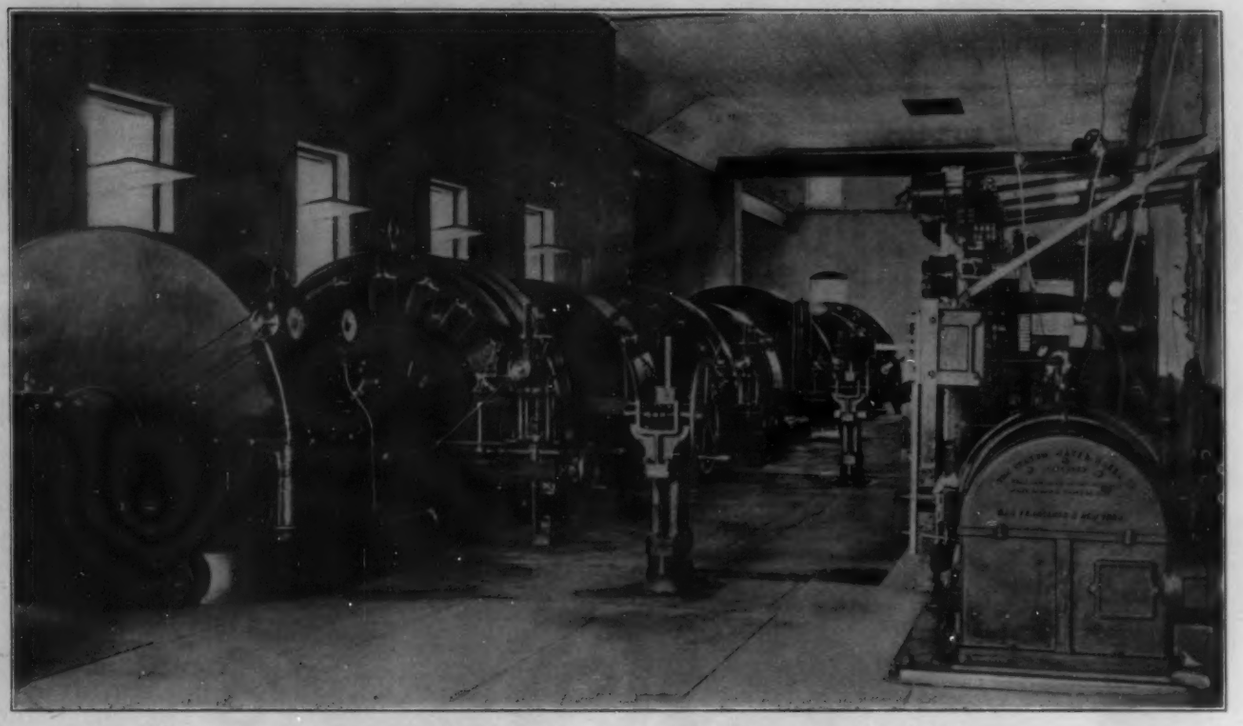
The fourth unit has a rated capacity of 2,000 kw. It consists of a generator of the so-called "water-wheel type," with revolving field and stationary armature. It operates at 300 r.p.m. delivering three phase current at a potential of 2,200 volts.

There are but two bearings, mounted on the masonry foundation. The water wheel is "overhung," that is, it is mounted at one end of the shaft, outside the bearing. It consists of a single runner on which are bolted cast-steel buckets, within a sheet steel housing. The nozzle is of the needle type, and is stationary. A type Q Lombard governor controlls the admission of water to the wheel by operating the needle in the nozzle. This water wheel was built by the Abner Doble Company of San Francisco, while all of the other main water wheels in this plant were furnished by the Pelton Water Wheel Company.

The generators were furnished by the Westinghouse Electric and Manufacturing Company, except the fifth unit, which was built by the General Electric Company; it is rated at 2,000 kw., and both the generator and water wheel are similar in type and specification to the fourth unit, just described. The nozzle of this water wheel differs, however, in that the needle is operated by a hand screw, while the governor, which is a Replogle, of the mechanical type, regulates by deflecting the nozzle, thus throwing the stream away from the buckets of the water wheel.

The second pipe line is carried directly through a worm and gear operated gate valve to the nozzle of the fourth machine. At some distance back of the building a feeder is tapped off of this pipe and is carried through a gate valve and then through a reversed, cast-steel three-pronged Y to the nozzle of the fifth machine. A second pipe is tapped off of the old pipe line and is brought diagonally across in the rear of the building and after passing through a gate valve, enters a branch of the Y casting. To the third branch of the Y is a third gate valve for use in the event that another pipe line be installed.

The exciter water wheels are operated by water



Interior of the Volta Power House, the older section in the foreground.

under a head of 500 ft. This water is diverted in Millseat creek and is carried through a ditch to a point directly above the power house, whence it is delivered through an 8-in. pipe. The source of this water is a large spring, near the top of the ridge, but in the bed of the creek. It has the advantage of being an independent and constant source for the exciters and as it is crystal clear makes an ideal operating medium for the governors. The governors are all operated by water from this source, but under a head of but 250 ft. Water is let down to a timber head-box, containing screens; from here it is carried to the power house in a 4-in. wrought iron pipe and distributed to the governors after passing through a Lombard triple screen.

There are four exciter sets, each having a 45 kw. multipolar generator delivering direct current at 125 volts; each is direct connected to its own water wheel, fitted with needle nozzles and enclosed in a cast-iron case. The first two sets are placed, one on either side of the switchboard; one of them has a 50 h.p. 500 volt induction motor coupled with it. This motor is supposed to be always connected to the live bus-bars on the switchboard, and, being operated by the water wheel at synchronous speed, "floats" on the circuit. Should a water wheel nozzle, which has a very small opening in these machines, become plugged with debris in the water, the motor automatically picks up the load, thus obviating the possibility of shutting down the exciters with the resultant loss of field and shut down of main machines.

The third and fourth exciters were installed separately, one for the fourth and the other for the fifth generating unit, and are equipped with type F Lombard governors.

There are two switchboards, the first, installed with the original plant, has four white marble panels. Three of these panels control the three 750 kw. generators, while the fourth is for the exciters. On each generator panel are mounted three ammeters, one voltmeter with a 3-point switch to connect to each phase, one d.c. field ammeter and one polyphase indicating watt meter. There are two sets of knife switches for the generator circuit which are connected to the two sets of bus-bars mounted on the rear of the switchboard. The exciter panel contains the regulation volt and ampere meters and exciter switches. The main leads from the generators to the switchboard are carried through the concrete floor in vitrified tile conduit.

The second switchboard has two generator and one exciter panels, also of white marble. The arrangement is similar to the old switchboard, except that the generator switches are of the remote control, oil-immersed type and are placed above and to the rear of the switchboard. The switchboards and apparatus were furnished by the Westinghouse Electric and Manufacturing Company.

Conveniently placed are water-level indicators to show at all times the level of water in the reservoirs. This device consists of a Weston voltmeter across the terminals of a No. 10 iron wire circuit. In series in this circuit, at the reservoir, are a number of 16 c.p. lamps which are automatically cut out by the movement of a float. There is impressed on this line the 125 volt direct exciter current, the variation of the lamp resistance and resultant variation of voltage at the voltmeter causing the proper movement of the needle.

A Brunswick ice machine, driven by a 1 h.p. single phase General Electric motor, gives a goodly supply of ice, which is a very welcome luxury during the summer months.

In the older section of the transformer house are nine 300 kw. Westinghouse, oil-immersed, air-cooled transformers, having a voltage ratio of 500 to 22,000

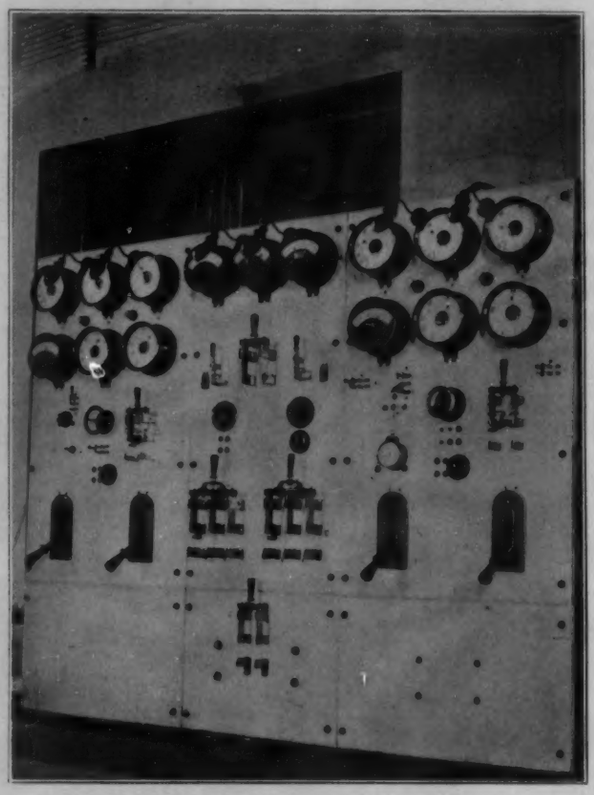
volts. Separated from these by a fire-proof wall are three 875 kw. General Electric water-cooled transformers, stepping the voltage from 2,200 to 66,000 volts, with star connection. Beyond these is a third compartment with three transformers similar to the last described.

In a room at the extreme corner of the building are two sets of "Kelman" 66,000 volt electric trip and manually closing oil circuit-breakers, one set for each bank of 66,000 volt transformers. These switches are of the pantograph type and seem to have proven the correctness of the principle involved by their satisfactory action on all occasions.

Kelman Oil Switches at Volta.

This switch should not be confused, by those familiar with the history of the development of high tension circuit breakers, with a crude experimental switch, built many years ago, at a time when the requirements for opening high tension circuits were imperfectly understood and switch development was in its infancy.

The construction of the switch is simple: It consists of a rectangular tank containing oil; the two leads are carried down through the cover in heavily insulated bushings to within a few inches of the bottom. A wooden rod having a vertical motion passes through the center of the top, between the lead bushings; to



Second Switchboard at Volta Power House.

this are hinged bronze strips which in turn are linked to a common point in the center of the tank. The movement is similar to that of the points of umbrella ribs, while the motion of the rod could be likened to the ferrule which slides on the center stick of the umbrella.

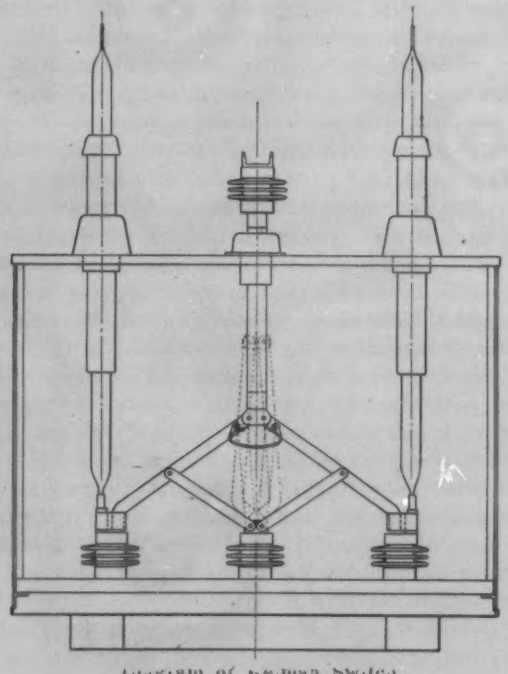
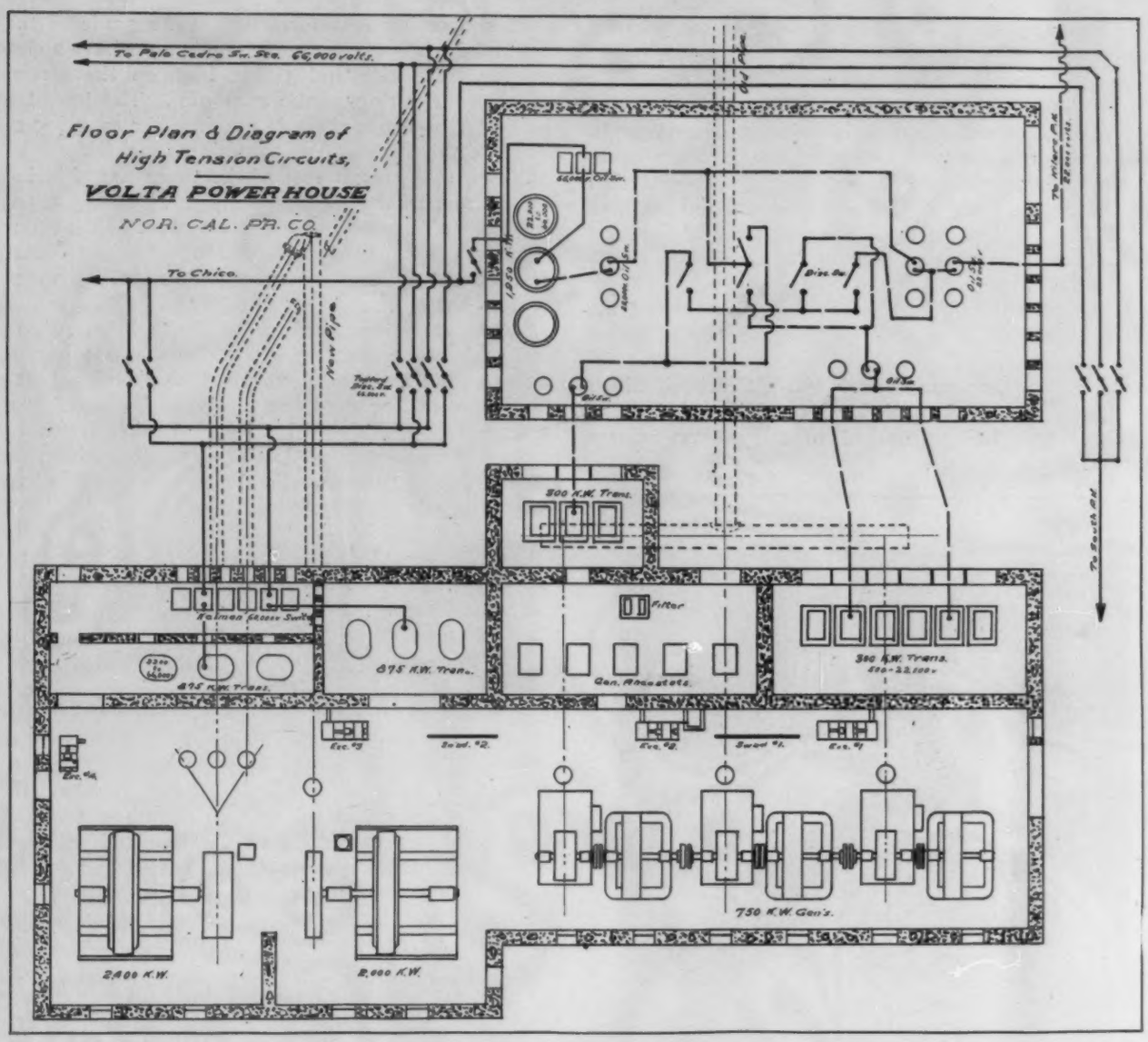


Diagram of Kelman Switch

The object of the pantograph movement is to give a horizontal break to the circuit, thus, at all times, maintaining the maximum head of oil over the break. This seems to be the secret of successful operation of



Plan of Volta Power House, showing arrangement of circuits.

oil-switches, where high voltages and heavy currents are to be controlled.

The circuits from the 22,000 volt transformers are carried into the switch house, as is also a circuit at the same voltage from the Kilarc power house. Within are disconnecting switches, which are a modification of the Masson-Taylor type. With these all necessary combinations of the circuits can be made. The accompanying one-wire diagram and plan shows the arrangement of all circuits.

There is in this building a set of three 1,250 kw. Westinghouse transformers, having a voltage ratio of 22,000 on the primary side to 66,000 on the secondary side, with star connection. This arrangement is a temporary one and was necessary that these transformers might get their current from either the Volta or the Kilarc plant. A voltage regulator is connected to a number of taps at the neutral end of the high tension windings of each transformer.

Radiating from this point are four transmission lines. One, having two circuits, one of which, operating at 22,000 volts, goes to Palo Cedro switching station and from thence are various branches to Redding, the smelter district and the west side of the Sacramento valley, as far south as Willows. This line will be changed to a 66,000 volt circuit and the 22,000 volt network will be fed through the De la Mar and Hamilton connections. The other operating at 66,000 volts is carried directly to Kennet and adjacent points. The second, a 22,000 volt line, is a single circuit to the Kilarc power house. The third line has a single 66,000 volt circuit and goes to Chico. The fourth line is similar and is a tie line between this station and the South Power House.

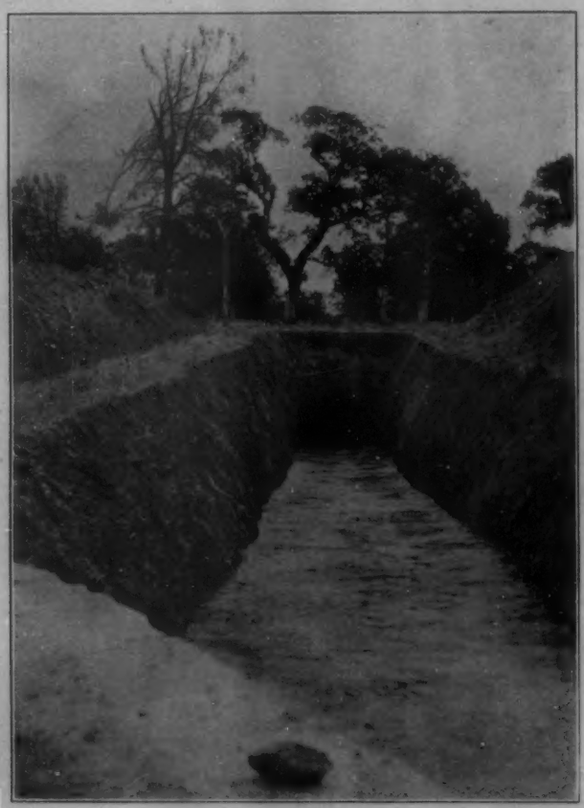
All circuits, after leaving the switch house, are carried to pole-top disconnecting switches. These are of the two-break, horizontal revolving type, but have, in addition, arcing horns, to facilitate the rupturing of any possible arc. Each jaw of the switch is equipped with a horn, while the swinging piece carries an inverted V, or double horn, which is given a spiral bend so as to be effective throughout the opening of the switch. These switches were designed and erected by H. A. Tedford, the superintendent of the plant. Each line is also equipped with pole-top, horn-gap arresters, for protection from lightning. The line, in all cases,

is connected directly to one horn, while the other is connected to ground without resistance.

South System.

Originally the discharge from Volta found its way to North Battle Creek to follow that stream throughout a drop of 1,500 ft. to where it joins the Sacramento river. The utilization of this drop, together with that of the South Fork of Battle Creek and the addition of the flow in both of these streams, was the basis on which three remaining power plants of the Battle Creek system were designed.

The flow from Volta is now conducted through a ditch which has a capacity of 3,000 miners inches or 75 second-feet. This ditch follows a more or less irregular course, crossing North Battle Creek, at which point the natural flow of this stream is added. The ditch is now being enlarged to carry 4,000 miners inches.



Outlet of Tunnel on South Battle Creek Ditch, immediately above the union with the ditch from Volta.

At a point five miles from Volta a junction is made with the South Battle Creek ditch and from there on it is known as the Union ditch. This runs for three-quarters of a mile, to the forebay of the South power house.

The South Battle Creek ditch carries the flow diverted from the stream of the same name. There is a small masonry diverting dam and the length of the conduit is five miles. There are along the route seven tunnels, aggregating one and one-quarter miles in length. The longest tunnel is 4,260 ft., there is another 700 ft., and the one just preceding the junction with the Volta ditch (shown in the view) is 1,270 ft. long. The rest of the tunnels are short.

These tunnels are all unlined, being cut through a self-supporting lava formation. The grade of tunnels and ditch is 0.2 percent. The tunnels have a clear opening 7 ft. wide and 4½ ft. high on the vertical sides, to the spring of the arch roof. The height at the center of the opening is 6½ ft. The carrying capacity of this conduit is 5,000 miners inches.

The total overall cost of the tunnels, not including the cost of the compressor plant, was $59,514.29, or $9.02 per running foot. The cost of the long tunnel alone was $32,772,26, or $7.68 per foot. These costs are surprisingly low and speak well for the management of the work.

A short distance before the South Power House forebay is reached there is a masonry waste wier or easement, built at the side of the ditch; it has a gently sloping top to facilitate the removal of any water to be wasted at this point; the edge is at the high water mark, so that any extra flow or backing up from the forebay due to regulation in the power house is handled automatically.

The forebay is a rectangular masonry structure. At its entrance are two timber sluice gates, operated by a rack and gear. Across the center is a grizzly made up of flat iron bars, set on edge, the whole being placed at a slant to facilitate cleaning. Behind the grizzly are heavy wire-mesh screens.

The pipe is inserted through the front wall and has an opening 72 in. in diameter. The pipe then tapers to a diameter of 54 in. and remains this size to within 400 ft. of the power house, where it is reduced to 48 in. This pipe was built by the company, the flange-steel sheets of the proper thickness and size being purchased in the Eastern market and delivered on the ground. It was punched, sheared and scarfed in the East and rolled and riveted together on the ground. The thickness varies from ¼ in. at the top to 9/16 in. at the lower end, the total weight of the pipe being 366,000 lb.

The fall or static hydraulic head on this pipe is 515 ft. and the length is 1,980 ft. The grade is fairly uniform, increasing slightly as the lower end is approached, the pipe being laid above ground for the entire distance. It is well underpinned with loose rock, carefully laid, which affords a satisfactory hold to the ground. Immediately before entering the power house the pipe is imbedded in a rubble masonry anchor wall 100 ft. long, its length being parallel to the pipe. The joints throughout are hot riveted, following standard practice.

The power house building is 32.5 by 70 ft. inside, the walls are of rubble masonry, 2 ft. thick, the roof is of corrugated iron supported on wood purlins which, in turn, are carried by steel trusses. The building is pleasing in appearance and, situated as it is at the edge of a very picturesque stream, gives an effect of simplicity and harmony.

The discharge from the waterwheels is directly into South Battle Creek, which is followed for a short distance and is then diverted and taken into the canal supplying the Inskip power house, five miles further down the stream.

The attractive feature of this power house is its extreme simplicity and efficiency. But one operator is required on a shift and, at that, there is very little for him to do, aside from the alertness and intelligence

Pressure Pipe to South Power House.

necessary in operating any large system at the moment when something happens.

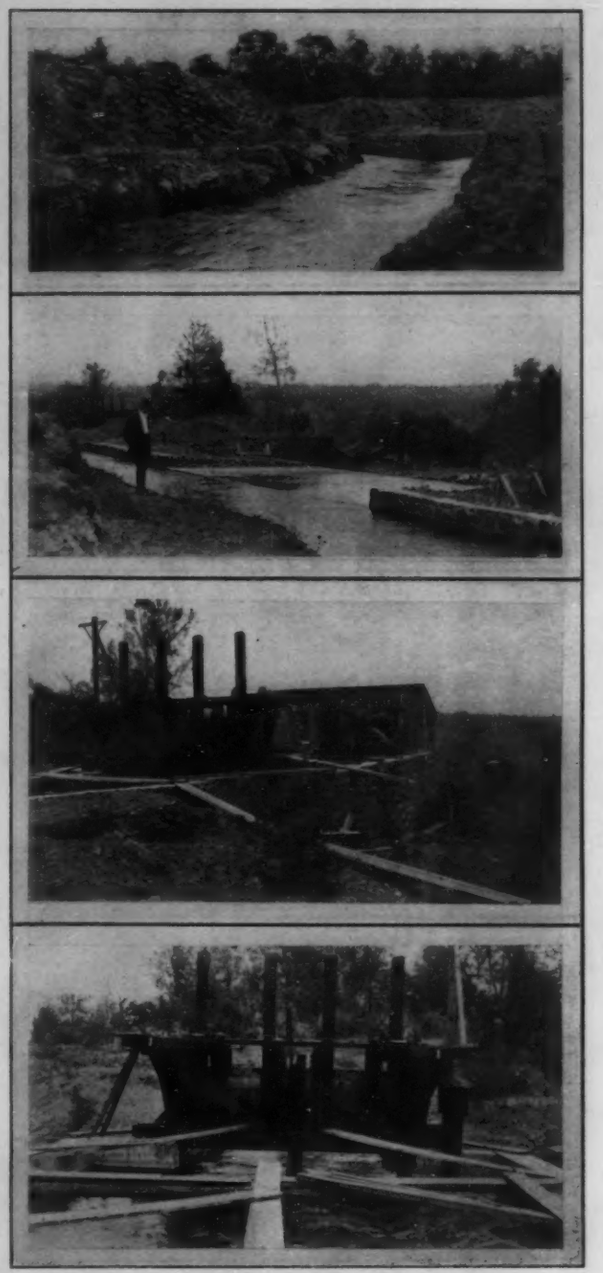
There is one main generating set and one exciter. The Westinghouse generator is rated at 4,000 k.v.a. and delivers three phase current at a potential of 6,600 volts. It is of the water wheel type, has but two bearings and a speed of 225 r.p.m. The bearings are water cooled and have piping arrangements for forced feed of the lubricating oil; this latter feature is, however, not found to be necessary and is not used. The shaft is hollow and its interior surface is water cooled.

The water wheels are two in number, that is, there are two runners, 7 ft. in diameter, fitted with steel buckets bolted to the wheel center; one on either end of the generator shaft, "overhung" outside of the bearings; each is in its own sheet steel housing.

Upon entering the rear wall of the power house flow in the pipe divides, passing through a cast-steel Y, thence, in each branch, passing through a worm and gear operated cast-steel gate valve to the nozzles. These are of the stationary needle type and are fitted with cylindrical deflectors over the stream, operated by a type Q Lombard governor.

The exciter is a 55 kw. multipolar generator, direct connected to an overhung water wheel within a cast-iron casing and fitted with a needle nozzle. This set supplies direct current at a potential of 125 volts.

The switchboard is conveniently placed in front of the generator and has two Vermont blue-marble panels. On the generator panel are mounted 3 a.c. ammeters, 1 field ammeter, 1 voltmeter, 1 indicating wattmeter, 1 graphic recording voltmeter, 1 graphic recording wattmeter, operating control for one remote control, electrically operated generator oil switch and the trip-control for two sets of electrically operated Kelman high tension oil switches. The switchboard was furnished complete by the Western Electric Company, mounted with indicating instruments by the Wagner Electric Company and graphic instruments by the Westinghouse Electric and Manufacturing Company.



South Power House Ditch System. (1) Junction of South Battle Creek Ditch with the Volta Ditch and the Union Ditch in the foreground. (2) Wasteway. (3-4) Views of Forebay and Sluice Gates.

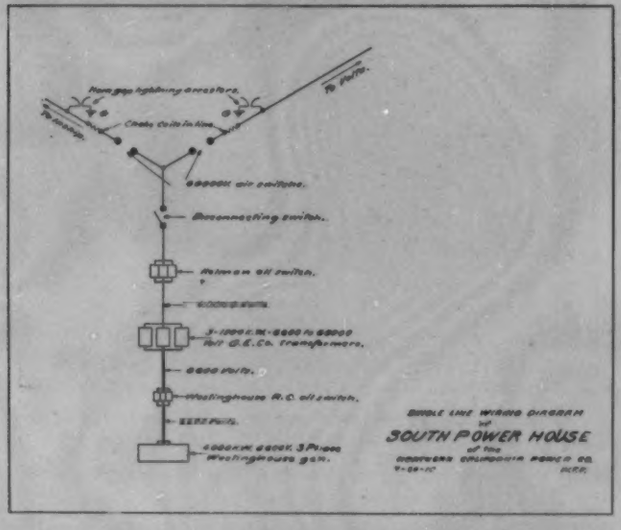
The exciter panel is mounted with the usual instruments and knife switches for two exciters and also contains a reservoir indicator similar to those already described.

At the west end of the building there are four compartments open to the main room, but separated from each other by concrete walls. Three of these

The South Power House.

compartments contain three 1,500 kw. General Electric transformers. They are of the standard water cooled type and are wound for 6,600 volts on the primary and 66,000 volts when star connected on the secondary side.

In the fourth compartment is placed the main generator switch. In a gallery, reached by a steel ladder, directly above this compartment are the Kelman high voltage switch sets, and over the transformers is a line of bus-wires connecting with it. From here the high tension lines are carried through windows fitted with plate glass panes to pole-top disconnecting



switches similar to those in use at Volta. There are also horn-gap lightning arresters. There are two transmission lines, one is the tie line before mentioned between this station and Volta, the other is a tie line to the Inskip power house.

The governor is operated by water under the full static pressure. The water is not, however, taken from the main pipe, but through a pipe laid the entire distance from the forebay. Here water is passed into a vertical drum which contains a screen, and the governor supply pipe leads from this drum. The pipe is a 4-in. standard wrought iron pipe for about one-half of its length, but for the remainder of the distance it is 2½-in. extra heavy pipe. There is a second screen inserted in the supply at the governor.

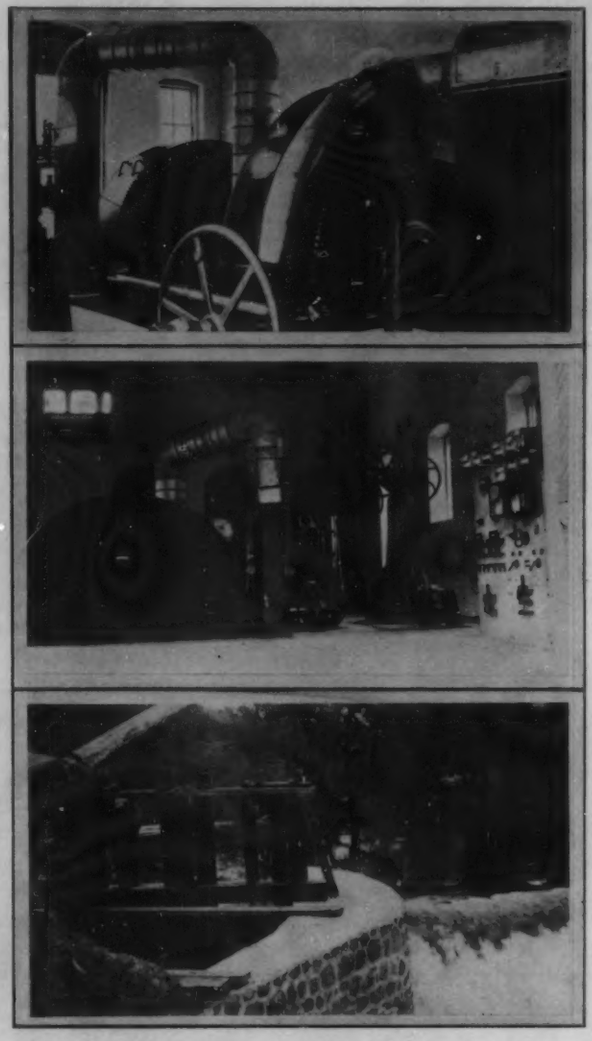
In the interior views of this plant it will be seen, that on the upper half of the frame of the generator on one side and the lower half, on the other, is a galvanized sheet iron casing to which is attached a large pipe of the same material. There is in the waterwheel pit considerable air suction due to the discharge. This suction was utilized by removing the cast iron plates over the nozzles and erecting a rectangular chimney of sheet iron. This connects to the sheet iron pipes and the suction through them is regulated by dampers. The core holes in the generator frame on the sides opposite the casing are plugged up. The effect of this device is to draw air through the ventilating ducts past the armature bars and the laminations, thus producing a ventilation which keeps the generator temperature within safe limits at all times. This very ingenious device was conceived and installed by an employee of the company, G. H. Murphy, although the same idea has been suggested by others, not knowing that it was being used here.

The Inskip System.

This system has been recently placed in operation. It derives its water supply mainly from the discharge of the South Power House, but receives also a smaller supply from North Battle Creek and a number of small creeks—that water which gathers between the line traversed by the Volta to South ditch and the Inskip plant.

A rubble masonry dam, having a gravity, ogee section, diverts the flow of South Battle Creek, a short distance below the South power house, through a set of sluice gates and a short tunnel, into the Inskip ditch.

This ditch has a nominal carrying capacity of 200 second feet or 8,000 miners inches; it is 4.45 miles from the intake to the forebay of the Inskip plant, including five tunnels and a short section of flume crossing Ripley Creek. The grade throughout is 0.2 percent, equal to 10.4 ft. per mile. The open ditch is 8 ft. wide on the bottom and 5.5 ft. deep to the berm line; the sides slope ½ horizontal to 1 vertical.

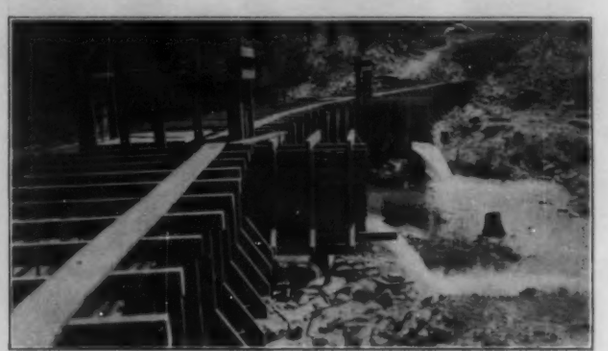


(1) 4000 kw. generating unit, South Power House. (2) Interior of South Power House, Transformers and Kelman Oil Switches seen in compartments in background.

A part of the ditch was excavated with a 1½ yd. capacity, Marion Steam Shovel, and the remainder by hand work. A comparison of costs is interesting and shows that, even through hard pan and rock, this modern method of constructing mountain ditches of large capacity is economical and advisable. The ground throughout is cemented gravel and lava, requiring blasting. The excavated capacity averaged 3 cu. yd. per running ft.

The overall cost of the ditch by pick and shovel methods was $4.00 per running ft. The cost with the steam shovel was 16 cents per cu. yd. The shovel was operated two shifts per day at a total cost of $36. To the cost of excavation is added blasting and cleaning up after the shovel. These costs per running ft. were as follows: Blasting, 60 cents; shovel, 43 cents; cleaning up, 80 cents; making a total of $1.83 per ft. as the cost of the ditch.

It has been the policy of this company to do its work in a manner to insure permanency and low cost of upkeep. With this in view, it has steadfastly refused to use timber flume for carrying large amounts of water, if it were possible to obviate its use. It has even gone so far as to drive crescent shaped tunnels, where timber flume might easily have been employed at one-third of the initial cost. The only piece of flume on this canal is used to cross Ripley creek and acts as a waste wier and sand box; it is short, the entire length being shown in the illustration, and is constructed in the most substantial manner; it is 8 ft. wide and 5 ft. high with three wasteways. The view of the ditch directly below that of the flume is of a section excavated by steam shovel taken from the same spot as the first view but in an opposite direction.

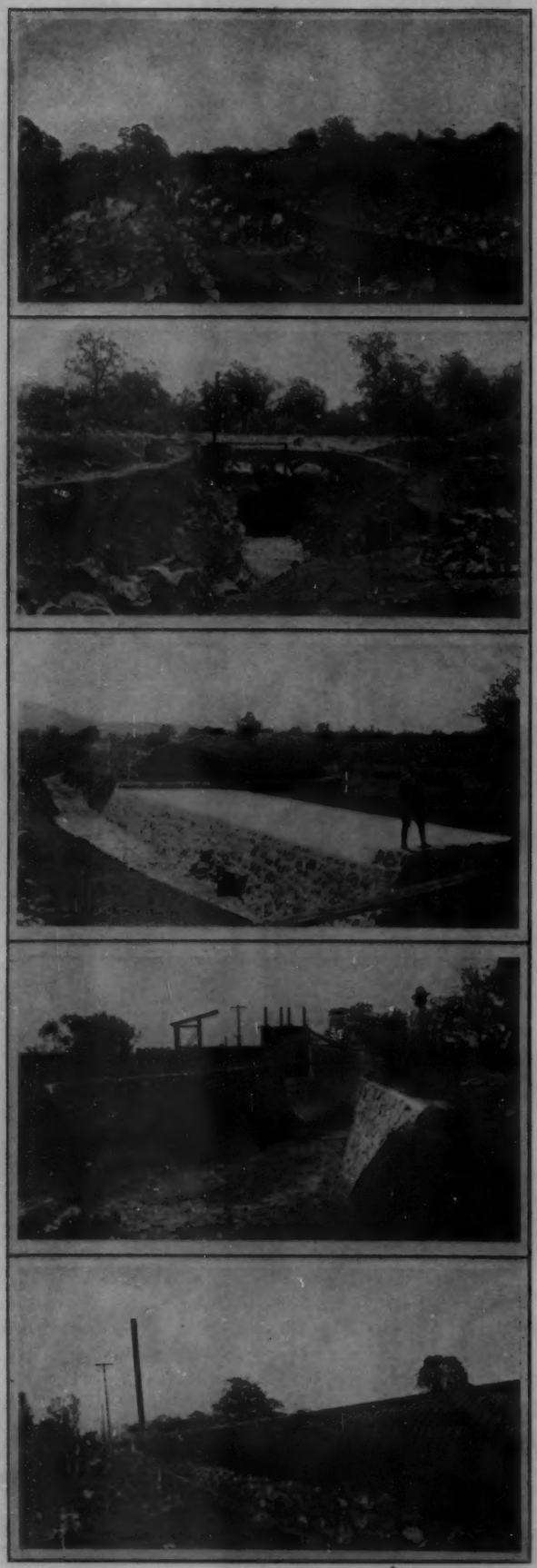


Flume Crossing Ripley Creek.

Section of Ditch Built with Steam Shovel.

The first and second tunnels have lengths of 1,779 and 1,212 ft., respectively, and are straight. The third is 729 ft. long and has three curves, the tunnel dipping into the hill to avoid what would otherwise have been flume in unsafe ground. The fourth consists of two sections, of 295 ft. in all, the first being straight and the second curved. The fifth also consists of two sections, the first having one curve and the second two; the respective section lengths are 418 and 516 ft. Material encountered in the tunnels was wash boulders, lava and volcanic ash.

The tunnels have a clear width of 10 ft., a vertical



Inskip Ditch System. (1) Excavating North Battle Creek Ditch. (2) Outlet of last tunnel. (3) Waste wier. (4) Entrance to the forebay. (5) Wood stave section of the pressure pipe, 6 ft. diameter.

height of 5.5 ft. to the spring of the arch and a total height of 8 ft. The excavated area averaged 75 sq. ft., and the cost varied from $9.20 to $9.60 per ft., although one section, where considerable difficulty was encountered, cost up to $16.00 per running ft.

The ditch from North Battle Creek has a carrying capacity of 5,000 miners inches and is at present under construction. The work is being done largely with the aid of the steam shovel.

The main ditch from South Battle Creek and the one from North Battle Creek join at the entrance of the forebay. This is similar in appearance, but somewhat larger, than the forebay for the South Power House. It is rectangular, with heavy rubble walls, and

Steam Shovel at Work Building Ditch.

is divided into three sections. The first two, which are opposite the rack and pinion operated sluice gates, have a low concrete barrier between them and sloping concrete floors, which can be drained and cleaned by means of gates placed in the rubble wall. The third compartment is separated from the second by a sloping grizzly and wire mesh screens. From the end of this compartment water passes into the pressure pipe.

A short distance from the forebay is a timber tank, divided into three parts. In each division wall are openings in which are inserted movable screens of fine-mesh brass wire. Water from the main pipe is brought to one end of this tank and passes through the screens, and is then led out of the other end into a 3½-in. steel casing which eventually reduces to a 2½-in. wrought iron pipe. This supplies water to operate the governors in the power house.

The pressure pipe has a length of 3,162 ft.; of this distance the wood-stave section is 2,160 ft. long and the steel section 1,002 ft. The inside diameter throughout is 6 ft. The wood-stave pipe is built of

the best selected red fir, only the heart of the tree being used, care being taken to eliminate knots and all but straight grained pieces. The timber was cut and finished in the mill owned and operated by the company. The pipe is held together with 5/8-in. round steel bands in two sections with two shoes of standard pattern, the spacing of which varies from 10 to 2 in. to the running ft. The unit cost of this pipe, exclusive of the steel bands, but including the laying, was $1.56 per running ft. The steel pipe varies in thickness from 3/8 to 1/2 in. and is hot-riveted throughout.

A receiver, which is a continuation of the pipe, lies alongside and parallel to the power house building; it is imbedded in concrete. The diameter is 6 ft., but after passing the three outlets to the first generating unit, tapers to 42 in. On its upper side, near its extreme end, is a drum containing a screen with a cleaner, operated by a screw and hand wheel; from this drum water for the exciters is carried through a 12-in. steel pipe. The static head is 378 ft.

The power house building is 125 ft. long and 37.5 ft. wide. It is divided transversely into two parts, the larger containing the generating machinery and the other the transformers and high tension apparatus.

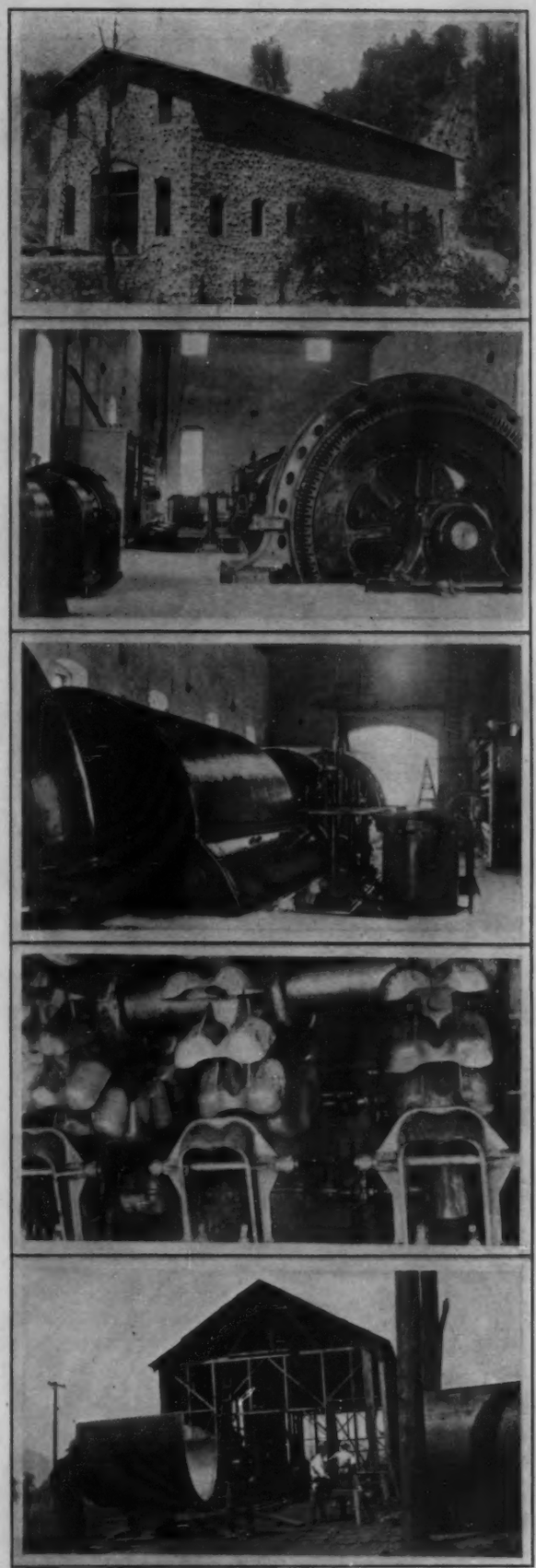
There are two main generating units, arranged so that the water wheels are adjacent. The first unit has a capacity of 4,000 kw. The generator delivers three phase current at a potential of 6,600 volts; it is of the water wheel type and has a speed of 225 r.p.m. There are three bearings, so that both the rotor and the runners are between bearings. The shaft is continuous. The waterwheels consist of three runners, having cast-iron centers and buckets, the latter being cast in pairs. There are two nozzles for each runner, the rear or upper nozzle being of the needle type, operated by a screw and hand wheel, the forward or lower ones having plain tips. Deflecting hoods are fitted to intercept the stream from each nozzle, and they are operated in unison by a type Q Lombard governor. Water is furnished each pair of nozzles from the receiver through three pipes, each of which is fitted with a 27-in. hydraulic gate-valve. The operating cylinders, which are supplied with water under full pressure, are 27 in. diameter. This large diameter, and the resulting enormous pressure on the gate admits of very slow closing against any resistance which might be offered.

The second unit is similar to the first, except that the capacity is 2,000 kw. and there is but one nozzle, like the rear nozzles in the first unit, for each runner. The hydraulic operating gates are also smaller, the diameter of both gates and cylinders being 21 in.

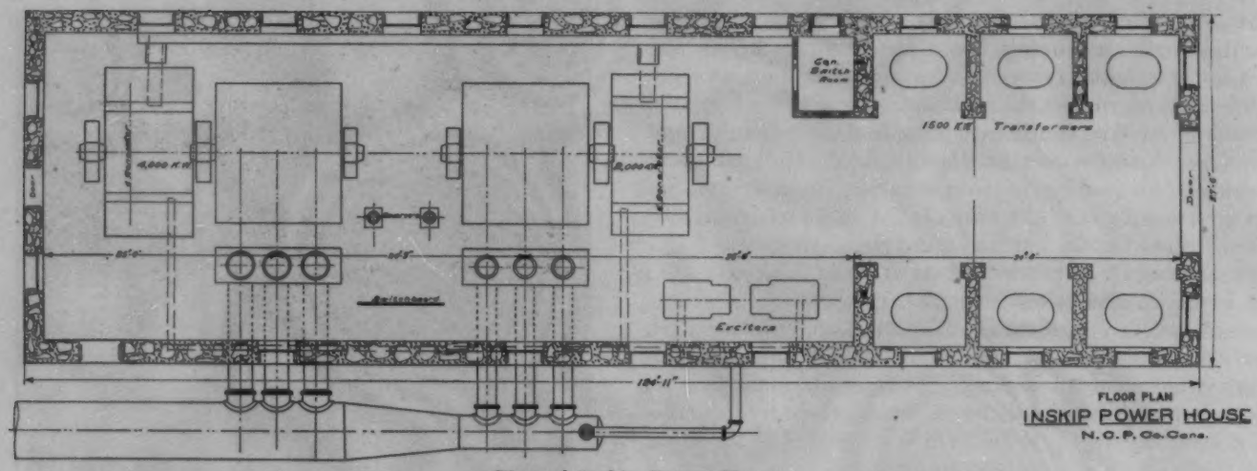
There are two exciter sets, either one capable of supplying excitation for both main generators. Each consists of a General Electric, 6-pole, 120 volt, 60 kw. generator connected to an overhung water wheel, equipped with cast-iron housing and needle nozzle.

All water-wheel apparatus in the Inskip plant was furnished by the Pelton Water Wheel Co.

The switchboard has one exciter and two generator panels; these are similar in mounting and equipment to those on the South Power House, except that the indicating instruments were furnished by the Westinghouse Company. There are two sets of generator bus-bars and consequently four sets of remote-control, generator oil-switches. These are placed in a



Inskip Power Plant. (1) Power House, showing pressure pipe in the background. (2) Interior, showing exciters and 2000 kw. generator in foreground. (3) Interior, looking towards opening into transformer sectian. A corner of 4000 kw. generator and 5000 h.p. water-wheel housing and hydraulic gate valves in foreground. (4) View of the interior of the 5000 h.p. water-wheel, showing runners, nozzles and deflecting hoods. (5) Pipe Shop.

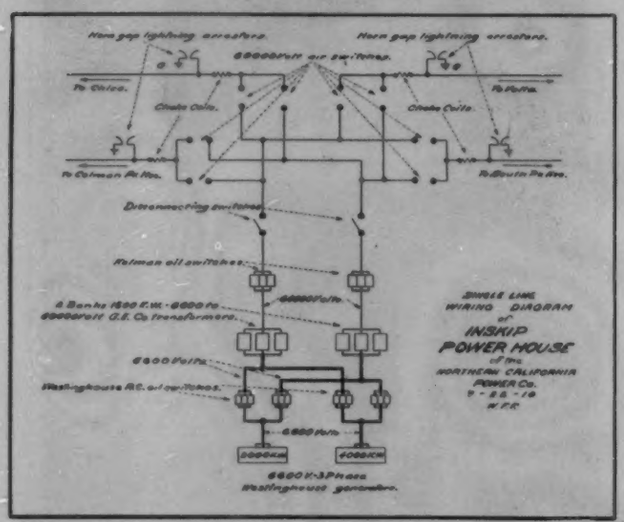


Plan of Inskip Power House.

fire-proof compartment at the end of the generator room.

There are six 1,500 kw. General Electric raising transformers, having a voltage ratio of 6,600 to 66,000 with star connection. The transformers are placed in individual cells having concrete walls, there being three on one side and a like number on the other side of the building, the passageway from the main entrance separating them.

Within the gallery over the transformers are the high-tension bus-lines and two sets of Kelman oil circuit-breakers.



Three circuits pass out of the building to pole-top disconnecting switches. These, at the present time, constitute a loop in the Volta to Chico transmission circuit, and the tie line to South power house.

The Coleman Plant.

This is the final and largest division in point of capacity, in the development of the Battle Creek watershed. All equipment for this plant is in process of manufacture and work on the ground is now well under way.

Water will be diverted by means of a masonry dam in South Battle Creek, immediately below the Inskip power house, and will be carried in a ditch in a north-westerly direction, skirting the hills between the two main forks of Battle Creek, crossing the North Fork and then following the ridge westward, which, further east, forms the drop at Volta, to a point about four miles above the junction of Battle Creek with the Sacramento River. Here a fall of 479 ft. is available. Water will be furnished to three main generating units through two pipes varying from 84 to 60 in. diameter. The generators will each have a capacity of 4,000 kw. and will be driven by Francis scroll case turbines having a rated output of 7,000 h.p The generators and turbines are being built by the Allis-Chalmers Company. Four 4,000 kw., 3-phase, 6,600 to 66,000 volt transformers and complete equipment of electrically operated, remote control, oil circuit-breakers, disconnecting switches and multiple cell arresters are being furnished by the General Electric Company.

This plant will represent the most modern practice in design and workmanship, and will be a notable addition to the many hydroelectric power plants for which the Pacific Coast is famous.

The transformers at South, Inskip and Coleman plants, while differing in size, are built to the same specifications for voltage and regulation, all having taps from 6,600 to 5,400 volts on the primary side, proportioned to give changes on the secondary in 2,000 volt steps.

The Kilarc System.

A description which would do justice to this division of the system would not be complete if only to give an outline of the various mechanical and electrical features. For the setting, in the wild grandeur of its mountains and forests, the wonderful variety in its coloring and yet the simplicity and fitness of it all, entwines this system, in itself a gem among power plants, in an atmosphere of romance. A steep, rocky canyon, the mountains on either side rising to heights of two and three thousand feet, the sides to the very bottom covered with a primeval forest of fir, spruce and pine; the edges of the creek growing in almost tropical profusion with wild rhubarb, dogwood and other flowering shrubs, a veritable riot of color in the deep shadows and brilliant high-lights. Such is the stream whence water is diverted for Kilarc.

To divert 3,500 miners inches of water out of a mountain stream, as a rule, requires a considerable diverting dam; not so here. This diversion has a con-

crete dam of the gravity overflow type; it is 1 ft. high and contains something less than 3 cu. yds. of concrete. It can be seen in the left of the picture. A large granite boulder on one side and another in the middle confine the stream so that it must flow over the dam, when not diverted. The intake to the ditch, with its sluice gates, shown on the right of the picture, is placed in a space blasted out, between the boulder and the south bank.

The ditch is 3¾ miles long from the intake to the forebay. There is, in this length, about 1½ miles of timber flume. This flume was adopted as a temporary expedient to obviate, for the time being, the cost of tunneling. There are, however, four tunnels, the one known as No. 2 having been recently bored to replace a section of flume.

The ditch is cut 4 ft. deep below the berm line; the depth of flow is 3½ ft. It is 8 ft. wide on the bottom and the top varies from 12 to 13 ft.

Tunnel No. 1 has a section of 3 by 5 ft. and is timbered; it has a length of 217 ft. Number 2, which is partly through hard rock and partly through lava ash, is timbered; it has a clear section of 6 by 7 ft. and a carrying capacity of 4,500 miners inches. The grade is 0.1 per cent. The cost of this tunnel was $5.50 per lineal ft.

Tunnels Nos. 3 and 4 have lengths, respectively, of 20 and 60 ft.; they are through rock and are not lined; their sections are 5 by 5 ft. The timber flume is carried through them. The grade of these tunnels, as well as that of No. 1, is ¼ in. to the rod.

The ditch empties into the forebay reservoir—seen in the background of the view of this reservoir—which covers 6 acres. It holds sufficient water to operate the power house for a period of eight hours, if no water were coming into it.

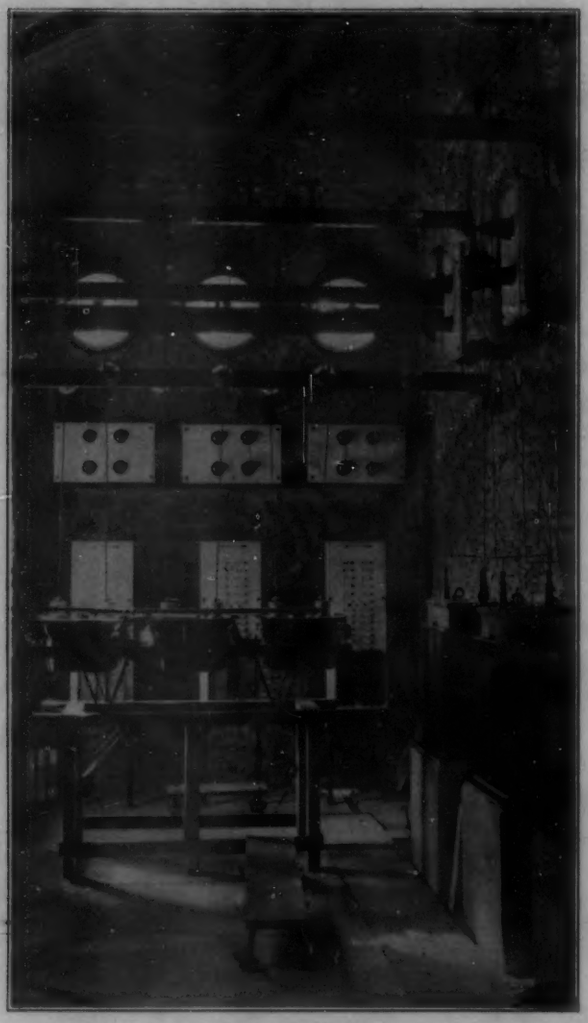
A timber forebay, equipped with screens, is placed well away from the banks of the reservoir, and from this a single steel pressure pipe is carried down the hillside to the power house. The first 600 ft. is, however, wood-stave construction, 60 in. in diameter.

The pipe has a total fall of 1,200 ft. in a length of 6,000 ft.; the steel part has a diameter of 42 in. and a thickness of ¼ in. at the top and a diameter of 36 in. and thickness of 13/16 in. at the power house. It is hot-riveted throughout, with butt and strap joints at the lower end.

The Kilarc power plant was placed in operation in 1903 and was thus the second installation of the system. It consists of two main buildings, the larger one containing the power generating machinery and the other, transformers, oil-switches and lightning protection. Both buildings follow the same general type of heavy masonry wall construction employed throughout the system and are placed parallel to the pressure pipe, one on either side. That section of the pipe lying between the buildings acts as a receiver and from it there are six horizontal outlets, two each for the two main generating units and two for the two exciter sets.

The main generating units are so arranged that the shaft line is parallel to the length of the building and the machines themselves are set "right and left handed," so that the water wheels face each other. The generators, built by the Westinghouse Company,

Kilarc Plant. (1) Diverting dam and intake in Cow Creek Canyon. (2) Forebay Reservoir. (3) Kilarc Power House and Transformer House. (4) Interior of the Power House. (5) Full load discharge in water wheel tail race.



Lightning Arresters, Static Interrupters and Oil Switches at Kilarc.

are rated at 1,500 kw. each; they are of the revolving field type, with cast base and pedestal bearings and operate at 300 r.p.m. They deliver three phase current at 2,200 volts. The water wheels are inclosed in a combination cast and wrought iron casing, have their own pedestal bearings and the shafts are connected with the generators through rawhide link couplings. There are two runners in each housing, equipped with steel buckets, bolted to cast steel centers. Water is supplied to the runners through deflecting nozzles, one of them being of the needle type, the needle of which is regulated by a hand wheel (seen in the left of the foreground of the interior view), the other nozzle has a plain tip. A type Q Lombard governor regulates the deflection of the nozzles; but there is in addition a hand regulating device, to be used in case of emergency. This is worked by a slanting hand wheel, through a thread and nut. In the rear of the nozzles are the main worm-and-gear-operated gate valves. The lowest view is interesting to the engineer, as it shows the nature of the discharge from one of the main water wheels; they were, at the time, carrying nearly full load; the capacity of the needle nozzle is about 50 per cent greater than that of the plain one, and the increased efficiency of the needle over the straight tip, which is the case here, is readily seen in this discharge. On the side of the straight tip, much water is passing the buckets, under great velocity, while on the near side the discharge from the wheel with the needle nozzle is comparatively quiet and lacking force.

The governors are operated by water under a pressure of 280 lb. It is carried through a 3-in. wrought iron pipe from a timber header some distance up the hillside; the header is supplied from a nearby spring.

There are two exciter sets, one on either side of the switchboard, and each consists of a 4-pole, 45-kw., 125-volt direct-current generator, connected on one side to an overhung water wheel and to a 50-h.p. induction motor on the other. The water wheel has a cast iron housing and is equipped with a needle regulating nozzle. The water wheel equipment was furnished by the Pelton Water Wheel Company.

The switchboard is in four panels and is similar in style and equipment to those at Volta. The generator switches are oil-immersed and are mounted on the rear of the board. The fourth panel contains the control for the induction motors. There is also an auxiliary lighting panel controlling all lighting circuits to the buildings, cottages, etc.

The transformer building is divided longitudinally by a masonry wall into two sections. In the side nearest the power house are the 22,000-volt Pacific Electric & Manufacturing Co. oil switches, Westinghouse low equivalent lightning arresters and static interrupters, for two outgoing circuits. One of these circuits is the tie line to Volta, while the other takes a northerly direction, and connects to the 22,000-volt network at De la Mar.

The lines are equipped with this system's standard pole-top, disconnecting switches and horn-gap lightning arresters. There is in addition, in the De la Mar line, for added safety in case the interior apparatus should fail, a Bowie "Kilarc" air-break, circuit-breaker. This is one of the first examples of this type of switch, and being the initial installation, took its name from this plant. It is equipped with solenoid release and can be electrically tripped from the switchboard. In the view of the power house, it is seen on the extreme left.

On the further side of the transformer building the compartment is divided into three parts; the center space is smaller than the other two and contains a spare transformer. In each of the other spaces, there are three 625-kw., oil-immersed, air-cooled transformers mounted on low trucks, six in all. They are wound on the primary side for 2200 volts and on the secondary for 22,000. In the wall, opposite each transformer, is a door through which they may be moved. Parallel to the building is a track over which a low flat-car may be pushed opposite to any door and thus facilitate the changing or moving of the transformers should it become necessary.

With the addition of the enormous storage of Tamarack Valley to this system the capacity of this plant, which was limited by the low water flow in Cow Creek, may be doubled. In anticipation of this added capacity, it is proposed to extend the present power

house building toward the creek to afford space for one 3000-kw. generating unit. This machinery is now in course of manufacture. The generator will be similar in type and make to those at the Inskip plant, while the water wheel will consist of a single runner, equipped with a ball-joint, deflecting needle nozzle, and to be supplied by the Abner Doble Company. Three 1500-kw. Westinghouse transformers will be installed and the high tension equipment will be changed to operate at a potential of 66,000 volts.

The power house buildings are surrounded and protected from the eroding action of the creek, during times of freshet, by a heavy rubble retaining wall. Across the creek is a comfortable club house and dwelling for the operators.

Transmission Lines.

There are two distinct types of transmission lines which have been adopted as standard for this system. The older is for 22,000-volt circuits and the later for 66,000. The first type follows closely standard practice of a decade past and consists of 30 or 35 ft. round cedar poles, No. 1 Provo, 40,000-volt triple petticoat glass insulators and solid copper wire. The higher voltage lines are mounted as a rule on 35-ft. round cedar poles, but with greater spacing between them, 14½-in., four-part Locke and Thomas porcelain insulators over steel, porcelain bushed pins and both copper and aluminum wire.

Except for a few places near towns roads are not followed by the transmission lines and the country, as a rule, is rough. Notwithstanding, the patrolmen cover the main lines every day and those of lesser importance at least once each week; it is necessary for them to ride on horseback.

Following is a list of the various lines with the general specifications; these may be readily located on the map of the system:

Substations.

There are in all 34 substations on this system, which vary more or less in design and capacity, due to the many different kinds of service which they render. These stations are at the following points: Redding, Iron Mountain, Horsetown, Germantown, Keswick, Kennet, De la Mar, Ingot, Copper City, Gladstone Mine, Brunswick Mine, Millville, Niagara Mine, Lappin Mine, Balakallala Mine, Mammoth Mine, Shasta, Manton, Gold Diggings, Coram, Baird, Proberta, Heroult, Anderson, Cottonwood, Red Bluff, Tehama, Molinos, Vina, Chico, Orland, Corning, Willows and Hamilton. Aside from these are the transformer equipments of various mines and smelters.

At Palo Cedro, which is on the Volta to Redding line, at a distance from Volta of 21.5 miles and from Redding of 6.7 miles, is a switching station in the 22,000-volt circuit. From this station radiate the lines extending to the south, through Red Bluff to Willows and to the north to De la Mar. At Redding the substation is placed in a group with the city water works. At Red Bluff it is operated in conjunction with the gas works and at Willows with the water works of the town.

The water works at Redding is owned by the company and the supply is pumped from wells driven in a gravel channel near the Sacramento river and delivered into a reservoir placed on a hill above the town.

In all towns, the company maintains well equipped offices and stores where supplies are carried.

At both Redding and Red Bluff the company owns the gas works; in the former place the equipment consists of two holders with a total capacity of 42,000 cu. ft., while at the latter place there are three holders, the first with a capacity of 10,000 and the other two having capacities of 5000 cu. ft. each. Gas is made by

TRANSMISSION LINES AND GENERAL SPECIFICATIONS

	Voltage.	Length.	No. Circuits.	Size Conductor.	Insulators.	Poles.	Spans.
Volta P. H. to Redding	22,000	28.2	2C.	4Cu.	Provo.	30 ft.	125 ft.
Redding to Iron Mountain	22,000	11.7	2C.	4Cu.	Provo.	30 ft.	125 ft.
Redding to Horsetown	22,000	9.04	2C.	4Cu.	Provo.	30 ft.	125 ft.
Keswick to Mt. Shasta Mine	22,000	4.24	1C.	4Cu.	Provo.	30 ft.	125 ft.
Keswick to Balakallala Jct.	22,000	12.75	1C.	4Cu.	Provo.	30 ft.	125 ft.
Keswick to Caribou and Sugar Lk.	22,000	8.	1C.	4Cu.	Provo.	30 ft.	125 ft.
Balakallala to Brunswick M.	22,000	21.	1C.	4Cu.	Provo.	30 ft.	125 ft.
Balakallala Jct. to De La Mar	22,000	14.5	1C.	4Cu.	Provo.	30 ft.	125 ft.
Kilarc to De La Mar	22,000	19.	1C.	4Cu.	Provo.	30 ft.	125 ft.
Kilarc to Volta	22,000	15.6	1C.	4Cu.	Provo.	35 ft.	225 ft.
Palo Cedro to De La Mar	22,000	18.	1C.	4Cu.	Provo.	30 ft.	125 ft.
Palo Cedro to Red Bluff	22,000	29.	1C.	4Cu.	Provo.	30 ft.	125 ft.
Red Bluff to Tehama	22,000	12.4	1C.	4Cu.	Provo.	30 ft.	125 ft.
Tehama to Willows	22,000	36.	1C.	4Cu.	Provo.	30 ft.	125 ft.
Orland to Hamilton	22,000	15.	1C.	4Cu.	Provo.	30 ft.	125 ft.
Copley to Old Diggings	22,000	4.	1C.	4Cu.	Provo.	30 ft.	125 ft.
Tehama to Vina	2,200	10.	1C.	4Cu.	glass	30 ft.	125 ft.
Palo Cedro to Mammoth	66,000	16.	1C.	1Cu.	4-pt. Por.	35 ft.	225 ft.
Volta to Palo Cedro	66,000	21.5	1C.	1Cu.	4-pt. Por.	30 ft.	125 ft.
Volta to Chico	66,000	70.	1C.	1 Cu. & 00Al.	4-pt. Por.	35 ft.	200 ft.
Volta to South P. H.	66,000	5.	1C.	1 Cu. & 00Al.	4-pt. Por.	35 ft.	225 ft.
South P. H. to Inskip P. H.	66,000	5.	1C.	1 Cu. & 00Al.	4-pt. Por.	35 ft.	225 ft.
Nord to Hamilton	66,000	8.5	1C.	1 Cu. & 00Al.	4-pt. Por.	35 ft.	225 ft.
Total length of 22,000 volt lines		258.43 miles					
Total length of 66,000 volt lines		126.00 miles					
		384.43 miles					

INDUSTRIAL PLANTS SUPPLIED BY NORTHERN CALIFORNIA POWER CO., CONS.

(1) Balakalala Smelter. (2) Mammoth Smelter. (3) Interior Mammoth Smelter. (4) Sub-Station and Beet Sugar Factory at Hamilton. (5) Bully Hill Smelter. (6) Heroult Electric Smelter. (7) Mammoth Mine. (8) Pumping Plant of the Central Irrigation Canal.

Lowe crude-oil apparatus and the daily capacity in each place is 100,000 cu. ft.

Current is supplied for loads of every conceivable nature. At Chico it is supplied directly from the transmission line and sold at a flat rate to the Pacific Gas & Electric Company; the substation at this point contains merely the necessary line switches and instruments for measuring the power supply.

The following list gives the various points of supply and the nature of the service:

		H.P.
Anderson	light and power	
Baird	light and power	
Balakalala Mine	power	700
Brunswick Mine	power	40
Bully Hill	light and power	
Bully Hill Smelter	power	700
California Copper Mine	power	
Central Canal	power	575
Copper City	light and power	
Coram	light and power	
Coram: Balakalala Smelter	power	1,550
Corning	light and power	
Cottonwood	light and power	
Crown Deep Mine	power	125
Germantown	light and power	
Gladstone Mine	power	350
Gold Leaf	light and power	
Hamilton City	light and power	
Heroult Smelter	power	3,000
Horsetown, dredge	power	250
Ingot	light and power	
Ingot; Afterthought Smelter	power	400
Ingot; Afterthought Mine	power	130
Kennet	light and power	
Kennet Mammoth Smelter and Mine	power	4,200
Keswick	light and power	
Keswick; Mt. Copper Co.	power	1,200
Lappin Mine	power	80
Little Nellie Mine	power	125
Los Molinos	light and power	
Mad Ox Mine	power	
Magra Summit Mine	power	150
Mammoth Mine	power	
Manton	light and power	
Millville	light and power	
Mountain Copper Co. Mine	power	400
Mt. Shasta Mine	power	
Orland	light and power	
Proberta, alfalfa mill	power	450
Red Bluff, gas works	light and power	
Redding, gas works, water works	light and power	300
Quartz Hill Mine	power	150
Reid Mine	power	250
Sugar Loaf Mine	power	
Tehama	light and power	
Summit Mine	power	50
Shingletown	light and power	
Uncle Sam Mine	power	50
Vina	light and power	
Washington Mine	power	150
Willows, water works	light and power	60

In San Francisco are the administrative offices, where are the headquarters of the president, Mr. H. H. Noble, who personally accompanied the writer in his quest for material for this article and Mr. Edward Whaley, the secretary and purchasing agent, who also rendered valuable assistance. At Redding is the office of the general superintendent, Mr. E. V. D. Johnson; at Volta, of Mr. H. A. Tedford, electrical superintendent, and at Kilarc of Mr. G. R. Milford, sueprintendent of the Kilarc division. All of these gentlemen and many others have rendered much valuable data and the broad knowledge exhibited of their various branches of work, together with the unquestioned interest in the welfare of the system, which seems to be universal, is a tribute to the management and a source of satisfaction to the owners of the company.

ENGINEERING DATA OF NORTHERN CALIFORNIA POWER COMPANY'S SYSTEM.

Hydraulic:

Watersheds: Battle Creek, Cow Creek, Burney Creek.

Storage Reservoirs: Manzanita Lake.
North Battle Creek Res. (building).
Tamarack Res. (building).
Macomber Lake.
Buckhorn Lake.
Cow Creek Res.

Ditches: 40 Miles.

Tunnels: 2.34 Miles.

Power Stations:

Volta:
8 750 kw. generators.
1 2,000 kw. generator.
1 2,400 kw. generator.
9 500 kw. 500/22,000v transformers.
6 875 kw. 2,200/66,000v transformers.
3 1,250 kw. 22,000/66,000v transformers.
Static hydraulic head, 1,196 and 1,250 ft.
Total capacity output, 8,500 h.p.

South:
1 4,000 kw. generator.
3 1,500 kw. 6,600/66,000v transformers.
Static hydraulic head, 515 ft.
Total capacity output, 6,500 h.p.

Inskip:
1 4,000 kw. generator.
1 2,000 kw. generator.
6 1,500 kw. 6,600/66,000v transformers.
Static hydraulic head, 370 ft.
Total capacity output, 8,000 h.p.

Power Stations:

Kilarc:
2 1,500 kw. generators.
1 3,000 kw. generator (to be installed).
6 625 kw. 2,200/22,000v transformers.
3 1,500 kw. 2,200/66,000 transformers (to be installed).
Static hydraulic head, 1,200 ft.
Present capacity output, 4,000 h.p.
Future capacity output, 8,000 h.p.

Coleman: (Under construction, ready for operation June, 1911.)
3 4,000 kw. generators.
3 4,000 kw. three-phase, 6,600/66,000v transformers.
Static hydraulic head, 479 ft.
Total capacity output, 16,000 h.p.

Total present generating capacity, 27,000 h.p.
Total generating capacity (1911), 47,000 h.p.

Transmission Lines:

22,000 volt lines, 258.43 miles.
66,000 volt lines, 126.00 miles.

Total.....384.43 miles.

Sub-Stations:

Operated by the company, 34.
Towns supplied, 28.

ANNUAL REPORT OF CITY ELECTRICIAN OF LOS ANGELES.

Some interesting facts are contained in the annual report of Mr. R. H. Manahan, city electrician of Los Angeles, Cal., recently filed with the board of public works of that city. The report covers the year ended June 30, 1910, and shows that the cost of electric street lighting in Los Angeles was $272,133.48. Of this amount, $216,605.53 was paid by the city for street arc lighting, while property owners paid $22,372.80 for special ornamental street lighting. The number of permits issued for electrical construction and repair work was 14,782, representing an increase of 32 per cent over the year before.

Mr. Manahan calls attention to the fact that more assistance is needed in the department of electrical inspection, which has to cover a territory of 100 sq. miles. He recommends that all wires should be enclosed in conduit in the fire district and in all public buildings and large apartment houses outside of the fire district. Attention is called to the fact that petitions have been presented for the ornamental lighting of Pico street, from Main street to Vermont avenue, 1.97 miles; Seventh street, from Boyle street to Hoover street, 4.13 miles; Sixth street, from Main street to Alameda street, 0.81 mile; Third street from Main street to Hill street, 0.21 mile, and First street, from Hill street to Chicago street, 2.10 miles. The present mileage of this type of street lighting is 6.8 miles, and with the extensions enumerated above the total will be about 16 miles of special ornamental street lighting.

During the year the report shows that 221 street arc lamps were installed, making a total of 2804 lamps in the old city proper. There are still a number of streets in Los Angeles that are poorly lighted, and Mr. Manahan recommends that at least 400 additional street lamps be placed in position during the present fiscal year. These new lamps will cover, as far as possible, the unlighted sections in the recent annexations as well as the city proper. The city electrician notes that Hollywood is lighted throughout by 50-watt tungsten lamps under a five-year contract and he suggests a revision of this contract by which the city may secure a more advantageous rate, at the same time assuring the company a fair return on its investment.

Examination for draftsman is announced by the United States Civil Service Commission on August 24-25, 1910, to secure eligibles from which to make certification to fill a vacancy in the position of marine-engine draftsman, $1800 per annum, Office of the Chief of Engineers, War Department. Applicants must have had at least ten years' experience. Graduation in mechanical engineering will be considered equivalent to four years of this required experience. Experience in dipper and hydraulic dredge design is desirable.

A test case of the recently enacted Los Angeles ordinance fixing the rates for electric current at 7 cents instead of 9 cents is to be made by the electric light and power companies of that city who have allowed two employees to be sent to jail in default of bonds for alleged violation of the law.

UNDERGROUND REAL ESTATE.

The recent announcement by the San Francisco assessor that he had decided to make a radical change in the system of assessing the underground conduits, cables, mains and manholes of gas and electric lighting corporations, etc., leads up through an interesting chain of possibilities. Heretofore such underground holdings of public service corporations have been assessed at about one-half the cost of their construction. It is understood that under the assessor's future policy they will no longer be classed as personal property but as real estate.

The practical, although perhaps unforeseen, effect of this change of the mains from personal to real property will be to create a vested right in or shift the title to those portions of the street thus occupied from the municipality to the corporations themselves. But many of those interested have not realized that when the public-service corporations become possessed of vested rights in the ground occupied by their mains the said property might possibly be subject to condemnation by the municipality under certain circumstances that may arise shortly. This may have the effect of compelling the city to condemn its rights of way for its high-pressure water system or other public uses. It shifts the burden of cost of the necessary changes in underground in the city streets for the accommodation of the high-pressure system, now under consideration, from the public-service corporations to the municipality.

The fact that there are twenty-two lines of mains and conduits for water, gas and electric lighting purposes in Market Street and that other downtown streets are also well filled with mains makes the subject one of immediate concern to both the corporations and the city authorities. It may cause greatly increased assessments for some of the corporations on their underground equipment. It would also enable these concerns, it is held, to increase their capitalizations proportionately and entitle them to issue additional bonds on their extensive, though narrow strips of downtown real estate. It has been ascertained by competent engineers that the expense of shifting the corporations' mains and conduits permanently to make way for the city's new high-pressure water mains will be immense and will fall very heavily on several of the lighting companies.

No provision has been made by the city to relieve the public-service corporations of these heavy expenditures. In case the corporations' attorneys prove that a title has been acquired by the companies assessed for alleged real estate values on the ground occupied by their mains, it seems to follow logically that the city's rights of way across their pipe-lines would have to be secured by condemnation. In that event damage suits might possibly follow and the municipality might have to pay the cost of the alterations as well as the damages. The outcome of the threatened situation will be awaited with great interest by all concerned.

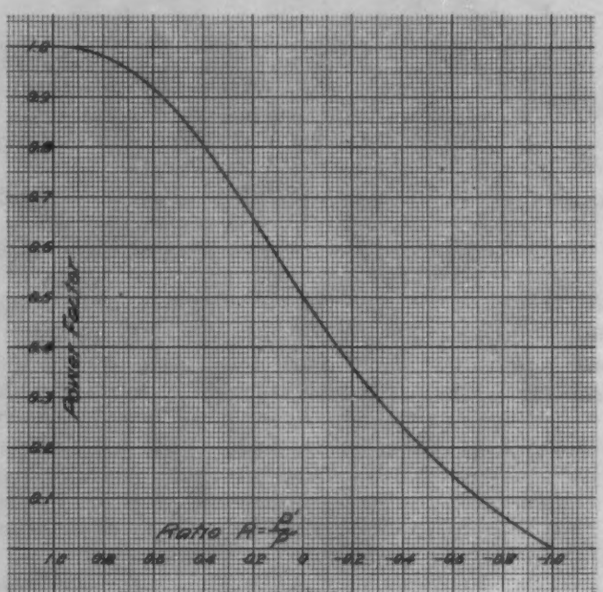
Synthesis of ammonia from nitrogen and hydrogen has been accomplished in Germany by subjecting these elements to a temperature of 500 degrees under a pressure of about 200 atmospheres. The ammonia is removed either by liquefaction or by the use of catalytic absorbents such as osmium or uranium.

CURVE FOR THE DETERMINATION OF THE POWER FACTOR OF A THREE-PHASE LOAD.

BY W. M. SHEPARD.

By means of the curve shown below the power factor of a three-phase load may be determined from two single-phase wattmeters or watthour meters or from one polyphase wattmeter or watthour meter.

The curve is derived from the formula given on p. 55 of the "Watthour Meter," by Shepard & Jones,



as reprinted from the Journal of Electricity, Power & Gas, March 19, 1910.

R is the ratio of the readings of the two single-phase meters or of the two elements of the polyphase meter (disconnecting one element and then the other.)

If P' is the smaller of these readings and P" the larger, $R = \frac{P'}{P''}$

Where one meter or one element of the polyphase meter registers backwards P' is taken as (—).

MANY NEW ELECTRIC LINES IN KOBE DISTRICT, JAPAN.

As a further stage in the development of transportation facilities in Japan, Consul David F. Wilber tells of the opening of four new trolley lines in the Kobe district:

The four miles of the Kobe Electric Company's line (18 miles contemplated), opened in April, cost $1,500,000 gold. The dynamos, rails, poles, and air brakes are American, the running gear and machinery of cars English, and the woodwork of cars and overhead wires Japanese make. The fare is 4½ cents, and the earnings for the first two weeks averaged $850 per day, and expenses $230 per day.

The Minomo-Arima Electric Railway Company's 18-mile line to mountain summer resorts, opened on March 15, cost $2,000,000. The rails, dynamos, boilers, and running gear and machinery of cars are American, the woodwork of cars and overhead wires Japanese make. The fare is 19 cents and the 30 cars are earning $940 per day.

The Keihan Electric Railway, 28 miles long, was opened on April 15, connecting the important cities of Osaka and Kyoto, and running through other large towns. The $3,500,000 capital was expended and a debt of $1,250,000 contracted. The materials nearly all came from England, though the overhead wires came from the United States, while the woodwork of the cars was made in Japan. The fare for the entire distance is 20 cents, and the daily earnings for the first two weeks averaged $1,500. The company's 30 cars, with an 8-minute schedule, will be supplmented by 20 cars with a 5-minute schedule. The Keishin Electric Railway, from Kyoto to Otsu, and the Uji Electric Railway, from Fushimi to Uji, now building, will connect with this line.

The Hyogo Electric Railway opened its first section —from Hyogo to Suma—on March 15; it will extend 12 miles along the shore of the Inland Sea to Akashi. The material has chiefly come from the United States, the woodwork of the cars and the overhead wires being made in Japan.

The new electric railways just opened having paralleled the track of the Government Steam Railway from Kyoto, through Osaka and Kobe, as far as Suma, on the Inland Sea, the authorities of the Imperial Government Railways, in order to meet the competition, have lowered the third-class fare for this section of the line to the same amount as that charged by the electric railway companies. They are also going to spend a large sum of money in track improvement and will put on more and faster trains.

PROPOSED MEXICAN LAW GOVERNING USE OF STREAMS.

By orders of the President of the Republic, the Minister of Fomento has just sent to the Chamber of Deputies a bill which is intended to govern the distribution of waters under federal jurisdiction, and which was drafted some months ago by the water bureau of the Department.

As stated in the communication which supports this bill, its object is to define the extent of the general jurisdiction, limiting it to the policing and regulation of the use of the waters, specifying the offenses which are not provided for under the Penal Code, as well as the penalties which are to be applied to such offenses.

The bill indicates the intention that, either by private initiative or by direct action of the Government, the works tending to favor and secure the development of the national products shall be realized as soon as possible, and thus avoid the importation of the staple articles which frequently occurs in our country through the total or partial loss of our crops.

The works for the timely utilization of the waters are not only advantageous to the nation, but they also more especially benefit each one of the States of the Republic through which such waters run. For centuries past these waters have crossed those same States without rendering any service, and have lost themselves in the ocean; and it is now time for the National Government to supervise and regulate the proper use of one of the principal sources of wealth with which our country has been favored.

JOURNAL OF ELECTRICITY
POWER AND GAS

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NOTICE TO ADVERTISERS

Changes of advertising copy should reach this office *ten days in advance of date of issue.* New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal." July 1895.
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FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

CONTENTS

H. H. Noble ..... Frontispiece
Northern California Power Company, Consolidated 107
By Rudolph W. Van Norden
Annual Report of Los Angeles' City Electrician 130
Synthesis of Ammonia 130
Examination for Draughtsman 130
Underground Real Estate 130
Curve for Determination of the Power Factor of a Three Phase Load 131
By W. M. Shepard.
New Electric Lines in Japan 131
Proposed Mexican Law Governing Use of Streams 131
Editorial 132
Personal 133
New Catalogues 133
Patents 134
Industrial 135
News Notes 137

Electric Shows

From time to time mention has been made in these columns of an electrical exposition to be held in San Francisco. Unforseen difficulties have delayed the opening of this show for nearly a year, but authoritative announcement is now made that all will be in readiness by September 17, the show to be open for eight consecutive days thereafter. In October a similar show is to be held in Denver.

These shows are a valuable means for popularizing the use of electrical apparatus. Many exhibitors are to make a special display of the application of electricity to the home. Aside from the healthful lighting that it has made possible, the electric current now offers a practical solution to the servant question. Cooking with electric heat becomes a pleasure and incidentally the food thus prepared is better. Electric clothes-washers, electric irons, vacuum cleaners and sewing machines are a boon to the hard-working housekeeper. When such devices can be seen in actual operation the public is soon educated to their use.

The educational value of these exhibits is useful in removing some of the distrust that is naturally associated with electricity because it is unknown. Electrical men throughout the country should put forth every endeavor to support these two Western shows in particular as they are the first large-scale attempts at introducing electric consuming devices to the Western people.

Power Utilization

A hydroelectric power development, like a railroad, is one of the few business enterprises that is started before there is even a demand for the commodity that it supplies. At its inception the tributary territory is frequently but sparsely settled and the inhabitants apparently have but little use for electricity. But experience has shown that a valuable class of settlers are attracted by cheap and convenient power. They create new industries which in turn demand more power and so the cycle continues like "the farmer who buys more land to raise more corn to feed more hogs." Many a system which was originally built to supply power to a distant market, subsequently finds a more profitable load nearby.

Ten years ago it required indomitable courage for the Northern California Power Company to build a plant in Shasta county, where a few prospect holes constituted the only evidence of the great copper mines to be developed and a few large ranches were the forerunners of the thousands of little farms into which they were to be sub-divided. Today these mines supply ore to four large smelters requiring sixty-eight hundred horsepower; in fact these smelters have poured forth such volumes of smoke as to damage the surrounding vegetation and make necessary the further aid of electricity in suppressing the noxious fumes. It is within this period also that alluvial gold has been found in the river bottoms that may be worked by electrically-driven dredges.

Farmers, likewise, were not slow to realize that water for irrigation can be pumped electrically and that their chores can be quickly and easily done by electric motors. One alfalfa mill needs four hundred and fifty horse-power to prepare food for cattle. The electric railways now grid-ironing the northern part of California give rapid transportation and incidentally use a part of the current generated by this company.

The most significant item, however, is a matter of three thousand horsepower supplied to the Heroult iron smelter where electric heat is converting ore to pig. The ore deposits are close to the power plant and the current is bought cheaply enough to make this project commercially feasible.

Heretofore the engineer's attention has been more largely devoted to the problems of power generation than to those of its utilization. But now each month sees some new method of applying electric power to the needs of the men who are the beneficiaries of those daring pioneers who risked millions of dollars in developing this country's latent resources.

PERSONALS.

John R. Cole has returned to San Francisco from the Yosemite Valley.

A. M. Hunt is making a two weeks' trip through the Pacific Northwest.

Anson H. Rees has been appointed buyer for the Ventura County Power Company, Oxnard, Calif.

E. R. Lilienthal and A. D. Schindler, of the Northern Electric Company, have been visiting at Sacramento.

J. H. Leary has been appointed assistant manager of the Central California Traction Company, of Stockton, Cal.

G. I. Kinney, Pacific Coast manager of the Fort Wayne Electric Works, is spending a few weeks in the Northwest.

A. C. Sprout, electrical engineer, is again at his office in the Crocker Building, San Francisco, after a month's illness.

Leopold Michaels, of the Metropolitan Light & Power Company, has returned to San Francisco after a trip to Europe.

Leon Bly, secretary of the Sierra Irrigation, Light and Power Company, was recently at San Francisco from Red Bluff.

C. L. Cory returned to his San Francisco office last Wednesday after a trip extending through Arizona and New Mexico.

Douglas Lindsay, chief engineer of the power plant in the Humboldt Bank Building, has returned from his annual vacation trip.

K. G. Dunn, of Hunt, Mirk & Co., has gone to Idaho on business connected with the Westinghouse Machine Company's agency.

Paul Shoup, assistant general manager of electric lines for the Southern Pacific, has returned to San Francisco after an Eastern tour.

E. C. Jones, chief engineer of the gas department of the Pacific Gas & Electric Company, including eighteen gas plants, will shortly leave for the East.

E. C. Johnson, heretofore with the engineering department of the Southern Pacific Railroad, has been appointed chief engineer of the Los Angeles Pacific Company of Los Angeles, Calif.

Delos A. Chappell, who has charge of the work of the Hydroelectric Company, and several other new California and Nevada developments, recently spent several days at San Francisco.

F. V. Lee, formerly assistant general manager of the Pacific Gas & Electric Company, is sojourning with his family at Manchester, England, his old home. He will remain abroad about a year.

A. C. Balch, vice-president and general manager of the Pacific Light & Power Company, of Los Angeles, was a San Francisco visitor during the past week. He is contemplating a European trip in the near future.

Seton Porter of the firm of Sanderson & Porter, is visiting the relief dam which has just been completed for the Sierra & San Francisco Power Company on one of the upper forks of the Stanislaus river. The water stands at a depth of 132 feet behind the dam.

H. P. Pitts, who was at one time at the head of the commercial department of the Pacific Gas & Electric Company, and was purchasing agent for the Great Western Power Company, during the past three years, has again joined the staff of the former corporation.

Joseph Mayo, who was connected with the management of the Contra Costa Electric Light & Power Company, is now superintendent of that distributing system covering Antioch, Martinez and other towns, for the Pacific Gas & Electric Company, the new owner.

Edward Boening, who was formerly attached to the superintendent's office of the Western Union Telegraph Company at San Francisco, has been assigned to take charge of the company's office at Seattle, Wash., succeeding District Superintendent R. T. Reid, who has resigned.

C. H. Gaunt, the new general superintendent of the Pacific division of the Western Union Telegraph Company, returned to his San Francisco headquarters last Monday after an inspection tour of the offices at Seattle, Portland and Tacoma. He was accompanied on the trip by I. N. Miller, Jr., his assistant.

NEW CATALOGUES.

"Brill Magazine" for July, 1910, in addition to a number of illustrated descriptions of new types of cars, contains an interesting account of special conditions at Tokyo, Japan.

Bulletin No. 4756, issued by the General Electric Company, gives a graphic description of the ventilation of horizontal steam turbine alternators, which will be instructive as well as interesting to those connected in any way with the operation of these machines.

Bulletin No. 4751, recently issued by the General Electric Company, is devoted to various types of that company's induction motor. The bulletin contains illustrations and descriptions of the design and construction of the skeleton frame motor of different sizes, and describes a vertical motor which can be furnished when this form is advantageous.

Catalogue 105 from Agutter-Griswold Company of Seattle, Wash., is a handsomely printed and bound list of electrical material manufactured by this company. It contains 126 pages and is divided into 5 sections, dealing respectively with knife switches, panel boards, steel cabinets, switchboards and miscellaneous material such as slate, copper, brass and insulating material.

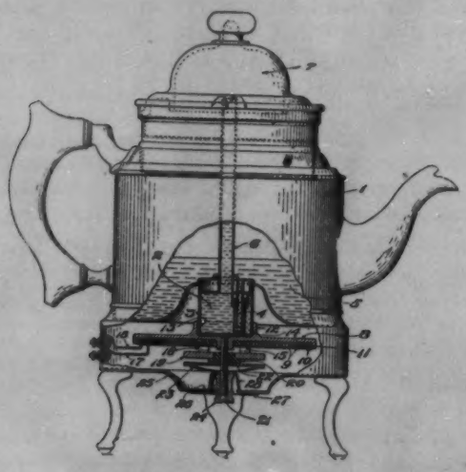
Publication No. 3968, recently issued by the General Electric Company, on electric cooking apparatus for hotels and restaurants, should be of considerable interest to managers of hotels and restaurants, due to the fact that it deals with a subject which is being given a constantly increasing amount of attention by hotel and restaurant people. The publication illustrates and describes various appliances designed especially for hotel and restaurant use, for example, broilers, roasting and baking ovens, toasters, plate warmers, stock kettles, automatic egg boilers, etc.

A bulletin on GE Mazda 400 and 500-watt incandescent lamps for standard lighting service has been issued by the General Electric Company, which describes that Company's large Mazda lamps for standard lighting service. These lamps are suitable for large stores, armories, factories, etc., and are economical substitutes for other building units of high candle-power and clusters of small lamps of low candle-power. The bulletin contains data regarding cost of lamps and service at various voltages, and illustrates also the fixtures suitable for use in connection with these lamps.

The General Electric Company recently issued a publicaton devoted to general illumination by its intensified arc lamp. This publication, No. 4742, contains a description and and illustrations in considerable detail of a lamp which the company has designed for general illuminating purposes, which is simple, mechanically, and reliable in operation. The principal characteristics of the lamp, however, are its high efficiency and the daylight quality of its light. The publication contains a color chart showing the illuminating values of various forms of lighting as compared with day light. This chart compares the incandescent, Welsbach, Nernst and the arc, with day light.

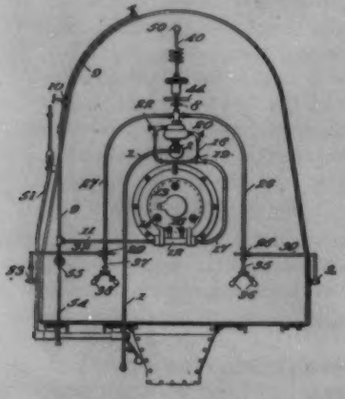
PATENTS

965,449. Electrically-Heated Apparatus. Horace B. Gale, Natick, Mass., assignor to Simplex Electric Heating Company, Boston, Mass. In an electrically heated apparatus, the combination with the part to be heated, of a metal receptacle having electric heating means in heat-conductive relation thereto,



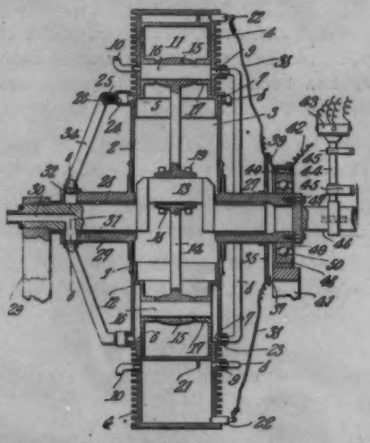
and provided with a recess in its upper side approximately fitting the said part to be heated, and a heat conducting body fusible at a lower temperature than said part of said receptacle filling the space between them, for maintaining conditions of maximum heat conduction.

965,719. Oil-Burner. Arthur H. Light, Los Angeles, Cal. In an oil burner the combination of an oil supply; a steam supply; an atomizing chamber in which said steam is tangentially delivered and in which said oil is delivered in a



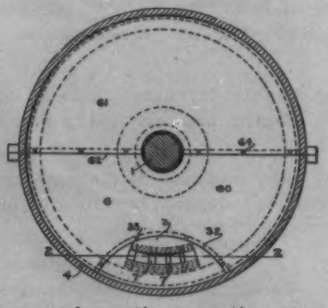
thin film; a second atomizing chamber; a second steam supply for said second chamber; a connection between said chambers; a pipe leading from said second chamber to the furnace; and automatic means for controlling the amount of oil delivered to said first mentioned chamber by the pressure of the steam generated by said furnace.

965,385. Revolving Gas-Engine. George Haniquet, Long Beach, Cal. A rotary two cycle gas engine comprising a fixed crank shaft having a feeding bore in one end, a plurality of compound cylinders mounted to rotate around said crank shaft and each provided with diametrically opposite ports in both its diameters, pistons in said cylinders connected with the crank shaft, conduits forming an independent connection between each cylinder and the feeding bore, and a series of independent conduits connecting the alternate cylinders and



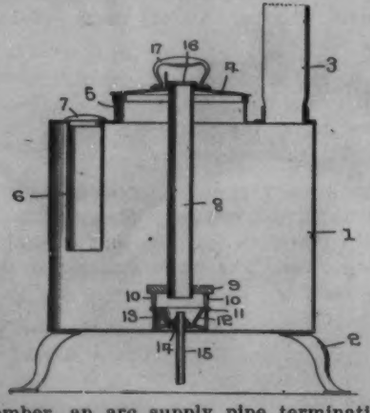
leading from the larger diameter of one cylinder to the smaller diameter of the companion cylinder.

965,412. Steam-Turbine. Rudolph Schlatter, Milwaukee, Wis., assignor to Allis-Chalmers Company, Milwaukee, Wis. In a turbine, a diaphragm discontinuous at one part of its



periphery, and a nozzle section co-acting at said part of said diaphragm entirely at surfaces of revolution having a common axis.

965,407. Burner. David L. Reese, Redlands, Cal. A burner comprising a bowl-shaped member, a spiral channel extending upwardly from the periphery of the base of said member, a fuel supply pipe extending vertically through the



shaped member, an arc supply pipe terminating above said bowl-shaped member, and a deflector supported on the upper portion of said bowl-shaped member.

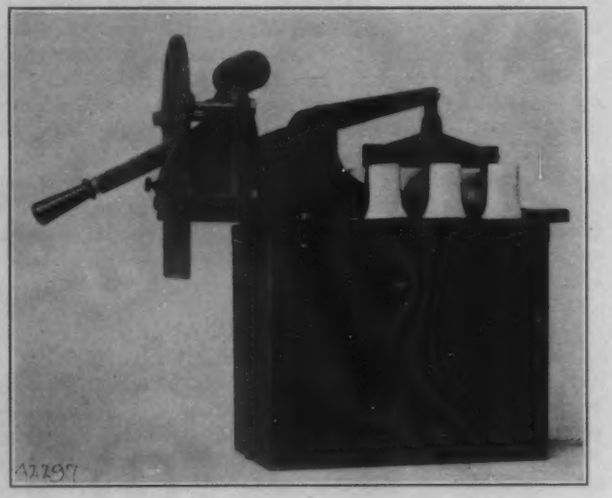
INDUSTRIAL

TYPE H OIL CIRCUIT BREAKERS FOR ALTERNATING CURRENT CIRCUITS,

Realizing the need for a simple, reliable and, at the same time, inexpensive oil circuit-breaker for use in general industrial application ultilizing low potentials, the Westinghouse Electric & Manufacturing Company, a few years ago, placed on the market the now well-known type H oil circuit breaker, designed for potentials not exceeding 600 volts and with a current carrying capacity of from 10 to 300 amperes. This breaker was designed for mounting on a wall or post or any location convenient to the operator.

So successful have been the principles of operation embodied in the type H circuit-breaker, that it has been decided to extend this line to include breakers of the same current carrying capacity adapted for switchboard mounting, and for use on alternating current circuits having potentials as high as 2500 volts.

The new type in addition to embodying all the distinguishing features of the old 600 volt type, also possesses several inherent advantages, the most prominent of which are the inverse time element and the "full automatic overload" release attachments.



Type H Oil Circuit Breaker.

The type H oil circuit breakers are equipped with overload release trip coils suspended from the frame of the breaker, immersed in oil and connected directly in series with the line. The plungers of these trip coils are retarded in their action by a device giving the circuit-breaker an inverse time element. The time element introduced is sufficient to permit the use of this type of circuit breaker for motor starting service. The mechanism is known as "full automatic overload," that is, it is equipped with a device that renders it impossible to close the breaker or to hold it in the closed position while a continued abnormal overload condition or a short circuit exists on the line. The time limit device referred to above, permits the breaker to be closed under a momentary overload or rush of current such as is incident to starting an induction motor or throwing the controller to "running" position.

An under voltage release atachment which opens the breaker whenever the line voltage falls below a certain predetermined value can be supplied for these type H oil circuit-breakers. It consists of a magnet coil connected directly across the line for voltages not exceeding 600 and through potential transformers for voltages higher than 600. This coil is self-contained and is so designed that it may be attached to the breaker without any modification in the mechanism.

The 600-volt style has a single break to each pole, while in the 2500-volt style there are two upper and two lower contacts for each pole, thus securing a double break per pole. The contacts consist of cylindrical brass rods, the lower ones being backed up by individual spiral springs to insure good contact, and form the well known "butt" contact type. This method, familiar in the multiple unit system of control on heavy street railway equipments, has been adopted with great success in oil circuit breaker practice. It insures good contact always and prevents any possible failure due to eating away the contacts by continued arcing. The compression springs mentioned take up any wear that may occur and render the contacts self-aligning.

EMERGENCY ELECTRIC LIGHTS FOR SHIPS.

The steamship "Alabama" of the Goodrich Line, which runs between Chicago and Muskeegon, Mich., has recently installed an interesting system of emergency electric lights which is furnished with current from a storage battery.

These lights have been installed to provide illumination in the corridors and on stairways in case of an accident to the generating apparatus, or, in case of the sinking of the vessel, lights would be available to aid passengers in making their escape after the hull of the boat had sunk some distance in the water.

In order to provide illumination as long as possible in case the boat should sink, the battery has been placed at the highest point of one of the upper decks.

The storage battery in use is composed of 56 cells type ET "Chloride Accumulator" in glass jars, manufactured by The Electric Storage Battery Co., having a rated output of 4.5 amperes for 8 hours. This battery will supply current for 10 hours on one charge for 25 four candle-power 110-volt carbon lamps which are in use in this installation.

The battery is charged during the day, and at night after the generators stop running, the lights used on decks, in halls and stairways are supplied with current from the battery alone. This system provides a reliable source of lighting which is always available in case of accident.

Similar battery equipments installed on other boats for furnishing current for emergency electric lighting service are also extensively used for the operation of wireless telegraph apparatus.

ERRATA NOTICE.

The first line, second column, page 83, issue July 23, 1910 in article on "Witt Automatic Feed Water Regulator and Oil Burner Governor" is superfluous and should be omitted. The word "boiled" in the next line should be "boiler." Furthermore, it should be understood that this regulator is simple in construction and has but one wearing part. The entire device is external to the boiler.

TRADE NOTES.

The national convention of the Electrical Jobbers' Association will be held at Del Monte, California, in the spring of 1911.

G. E. Witt Co. of San Francisco has just received an order from Densmone-Stabler Refining Company of Los Angeles for four sets of their automatic oil burner governors and boiler feed regulators.

THE WESTERN ELECTRIC WATCH-CASE BATTERY GAUGE.

The No. 30 battery gauge recently developed and placed on the market by the Western Electric Company is a compact instrument for measuring accurately and efficiently the strength of telephone dry batteries used in connection with

Western Electric transmitters. It is designed for connection to three cells in series, duplicating conditions of the local battery subscribers' set. It contains apparatus for gauging current through two resistances, corresponding to high and low resistance transmitters.

The No. 30 gauge is in watch-case form, and the views which are shown herewith demonstrate the convenience of the arrangement. It contains no scale, but is designed

merely to show the point at which batteries should be put out of service. For the high resistance transmitter a mark above the arc on the face of the gauge is used to denote the cut-off point. This means that current from the three cells is being sent through 20 ohms resistance. The cut-off point is 140 milli-amperes, a point which conforms with the best telephone practice.

When the stem of the watch-case is depressed, 15 ohms resistance are removed, leaving only five. This produces the conditions of the low resistance transmitter, and the cut-off point, which is indicated below the arc, is 420 milli-amperes.

WILMETTE PUMPING STATION.

The drainage canal and incident works of the Sanitary District of Chicago has attracted the attention of engineers for several years. Of chief importance has been the method thus employed of securing a pure water supply for a city of this size. Previous to the beginning of this work the sewage of the entire city was discharged into the harbor directly, or through the Chicago and Calumet rivers. This condition of sewage pollution led to sever epidemics of typhoid fever and Chicago had an unenviable reputation for this disease. Long and serious study of conditions by both engineers and sanitarians led to the determination of the system finally adopted for removing the trouble.

This consisted in the construction of a canal, about 28 miles long, connecting the Chicago and Desplaines rivers, striking the latter near Lockport. By this means the direction of the flow of the Chicago River was reversed and the waters of Lake Michigan were used to dilute the sewage which later finds its way to the Mississippi River.

Upon the completion of the canal proper further safeguards were carried forward, first the building of an intercepting sewer along the lake shore on the south side of the city extending as far south as 87th Street and covering all that section included up to the Chicago River. At 39th Street a pumping station was built which not only handled the sewage collected by the intercepting sewer, but also took large quantities of water from Lake Michigan and discharged it with the sewage into the south branch of the river, thus tending to maintain a current which would keep it free from any dangerous or disagreeable condition.

This station contains four Allis-Chalmers centrifugal pumps for handling sewage and two screw pumps for taking the water from the lake. It has a total capacity of two billion one hundred million gallons (2,100,000,000) per twenty-four hours, which is the largest pumping capacity of any single plant in the world. After this was completed, work was started on what is known as the Lawrence Avenue Station which handles the sewage from the intercepting sewer along the north shore of the city and also takes water from Lake Michigan and discharges it into the north branch of the Chicago River.

Beside these projects already completed, the district now has under construction what is known as the north shore channel on which will be located the Wilmette Pumping Station. There is also in contemplation a plan for the reversal of flow in the Calumet River at the south of the city and when this is completed, together with certain sewage pumping stations which the city itself maintains, the entire shore front of Chicago and its immediate vicinity will be well protected.

The construction of the north shore channel is progressing quite rapidly now and probably within the course of the present year will be completed and in operation. This channel takes water from Lake Michigan near Wilmette and discharges it into the north branch of the Chicago River. From the Lake to Sheridan Road, a distance of about 400 ft., the water will flow by gravity. Here a viaduct carries this road across the canal channel, and built as a part of the viaduct and beneath it is the pumping station and a lock.

Beneath the center span of the bridge will be located the pumping station. This will consist of a motor room and transformer room each 29 feet by 54 feet inside dimensions. Four horizontal screw pumps each having a capacity of fifteen thousand cubic feet per minute against a head of 3 feet when running 75 r. p. m. will be installed. Each of these pumps will be driven by a 150 h.p., 3 phase, 60 cycle, 2300 volt induction motor. The pump runners will be located on the easterly side of the building with the shafts extended horizontally into the motor room. These pumps are similar in construction to others of the same character installed by Allis-Chalmers Company in the 39th Street and Lawrence Avenue stations.

NEWS NOTES

FINANCIAL.

ASHLAND, ORE.—Bids will be received up to August 2 by the city recorder for the purchase of $25,000 electric light bonds of this place.

KENDRICK, WASH.—The proposed bond issue to provide a fund of $10,000 for the purpose of installing an adequate water system has been defeated.

JACKSONVILLE, CAL.—The City Council has called an election for August 1 for the purpose of voting $30,000 bonds for the establishment of a gravity water system.

MODESTO, CAL.—The city will hold a bond election for municipal improvements. Sewer improvements, $65,000; water system, $15,000; street improvement, $10,000; fire department, $10,000.

MOUNTAIN HOME, IDAHO.—Electors of the village of Mountain Home, Elmore county, Idaho, will hold an election on the 17th of August for the purpose of submitting to the qualified electors the question of authorizing the issue of $48,000 of negotiable coupon bonds; interest at 6 per cent, due in 20 years.

PORTERVILLE, CAL.—A 500,000 gallon reservoir on Murry or Park hill and a pumping plant on the flat below, to be used in conjunction with the present plant has been decided upon at a consultation of the City Trustees. The voters of the city will be called upon this summer to approve about $50,000 in bonds to build the reservoir and put in the pumping plant.

INCORPORATIONS.

OROFINO, IDAHO.—The Clearwater Telephone & Telegraph Company has been incorporated for $40,000 by Samson Snyder.

SEATTLE, WASH.—The Sunset Falls Light & Power Company, capital $100,000, has been incorporated by J. A. Soderberg, 310 Alaska building; G. N. Miller and J. S. Jurey.

REDLANDS, CAL.—The Mill Creek Pipe Line & Reservoir Company has been incorporated by N. B. Hickley, J. M. Cole, J. H. Strait, J. M. L. Frink and W. H. Van Lenrein, with a capital stock of $50,000.

HEDGESVILLE, MONT.—The Montana Telephone Company has been incorporated by W. E. Ford et al, for $10,000. This company will take over the interests of the local company and a number of rural lines will be constructed.

ILLUMINATION.

HELENA, MONT.—Dr. C. E. Schroeder, and J. C. McCarthy have been granted a franchise for a gas plant in this city.

PASADENA, CAL.—A five-year contract has been signed with the Pacific Light & Power Company for the installation of a new tungsten power system of 550 lights.

JACKSON, CAL.—The natural flow of water getting short at the summit, the Pacific Gas & Electric Company will order the water turned out of Blue Lakes, Alpine county, for use to furnish power for the plant at Electra, this county. The lake supply will last about seven weeks.

SAN FRANCISCO, CAL.—An advance in wages of 25 cents per day has been granted the electrical workers in the employ of the Pacific Gas & Electric Company. The agreement has been signed here between the Pacific District Council of the Electrical Workers and the company. Under the new agreement outside electrical workers will receive $4.25 per day with time and a half overtime and $5 per day for foremen. The raise dates from June 1 of this year. All the outside electricians from San Francisco to Central California are benefitted by this new schedule and this means that 1000 men have received a wage raise. The new schedule adds $150,000 per year to the company's pay-roll.

TRANSMISSION.

ELK CITY, CAL.—C. S. Batchelder, superintendent at the South Fork mine, reports that a power plant is planned for the near future.

OROVILLE, CAL.—John A Hall of Plumas county and George H. Sparks of this city have filed a notice of the appropriation of 2000 inches of the waters of Coldwater creek below Buck's ranch, in Plumas county. The intention of the locators is to carry the waters of the ditch and pipe line a distance of about 650 feet from the point of diversion to the site of the proposed power plant.

BOCA, CAL.—A survey is now being made along the Truckee river in the vicinity of Boca for the construction of a power plant to cost $750,000. The Truckee river will be tapped above Boca, and a long tunnel through the mountain south of the river will be constructed to carry the water, which will empty back into the river about a mile below Boca, insuring over 10,000 horsepower to supply lights and power to Reno and other cities along the Truckee river.

SAN FRANCISCO, CAL.—The Sierra and San Francisco Power Company, allied with the United Railroads, has filed papers by which it appears that there has been a reclassification of its bonds. When the company was first organized it authorized a bonded indebtedness of $20,000,000. First mortgage bonds were authorized to the amount of $14,000,000 and second mortgage bonds in the sum of $6,000,000. The rearrangement places the first mortgage bonds at $10,500,000 and the second mortgage securities at $9,500,000. The total remains as before at $20,000,000.

THE DALLES, ORE.—The American Power & Light Company, the new holding concern organized last month to take over the properties of the Northwest Corporation located in Idaho and Oregon, has purchased the hydroelectric plant and distributing system of the Wasco Warehouse Milling Company, of The Dalles. The plant consists of a hydroelectric station on White river and transmission lines to Dufur and The Dalles, Ore. The energy is used for lighting and power, including the operation of the large flour mills of the Wasco company.

SPOKANE, WASH.—Five hundred thousand dollars will be expended by the Washington Power Company in tunneling under the Spokane river for about a quarter of a mile west from the upper falls in the business district of Spokane, where four water wheels of 1000 kw. capacity will be installed to generate 53,500 h.p. Work has been started by the Church & McCoy Company of St. Paul, which also has contracts to erect a three-section car barn to cover a block. The tunnel work is similar to that under Niagara Falls and presents the same engineering feats. "This method of utilizing the power of the Spokane river will give us a direct fall of 144 feet or about twice what we have at present by using the lower falls," said D. L. Huntington, president of the company. "It is impossible to give the entire estimated cost at this time, as this preliminary work on the shaft will have to be completed first to get at the real tunneling work. It is safe to say, however, that the cost will

be around $500,000, possibly more. We have set no specific time for completing the work, that depending largely upon the engineers after they have made their estimates when the first shaft is sunk. The work on this shaft will go right ahead." Three temporary compressed air drills, each of 250 horsepower, are in operation and will be supplemented by a compressor of 1200 cubic feet a minute. The working shaft of the tunnel, 10 by 20 feet, will be sunk 150 feet. There will be three compartments, two for elevators and one for the pipes and other stationary working equipment. From the bottom of the shaft the tunnel will be driven 1000 feet up and down the river, the western extreme terminating just below the lower falls now used by the power company. This tunnel will be 22 feet in height and 27 feet in width. The company also is surveying a route for a new power line from Post Falls, Idaho, to Newport, Wash., to supply light and power to Newport, Sandpoint and other cities in eastern Washington and northern Idaho.

TRANSPORTATION.

ALBANY, ORE.—The Albany & Interurban Electric Railway has been granted a franchise by the city council.

OREGON CITY, ORE.—G. Clarence Fields has announced his intention of constructing an electric railway from Oregon City through the Molalla valley.

SALT LAKE, UTAH.—An application for a franchise to run electric cars through the city has been made by the Salt Lake and Ogden Railway Company.

LOS ANGELES, CAL.—By a vote of 5 to 2 the City Council of Long Beach has decided to table the application of the Pacific Electric Railway for an entrance to the water front of the inner harbor.

LOS ANGELES, CAL.—Preparations for beginning of improvements by the Los Angeles-Pacific Comapny that will cost $5,000,000 or more, are complete. The first work will be the construction of a series of tunnels in the southwestern part of the city.

REDLANDS, CAL.—A. C. Denman Jr. of Redlands is at the head of a syndicate that will build an electric line starting at Chino and passing through Riverside, Allessandro valley to Perris, Lakeview, San Jacinto, Hemet, Elsinore, Corona and Chino. The central power plant is to be in that town.

GILROY, CAL.—Gilroy, as well as all of southern Santa Clara valley may expect interurban car service within a short time. It is the intention of the Peninsula Electric Railway managers to extend their line to this section when the work of completing the improvements between San Jose and San Francisco is ended.

CHEHALIS, WASH.—W. H. Allen & Co., engineers of this city, have helped to complete the survey for a $3,000,000 trolley line to be constructed between this place and Centralia and the various towns along the line to Randle, to be constructed by eastern capital. It is announced that work will begin this summer.

PASADENA, CAL.—Negotiations are pending between the Pasadena Rapid Transit Company and the North End Syndicate of Los Angeles property owners, whereby the syndicate is to furnish capital needed for the completion of a road building project and in return the road is to make its terminus at the Plaza in Los Angeles.

ROSWELL, N. M.—The Berendo Irrigated Farms Company, which acquired the Roswell electric light plant, will put in a modern electric street car system in this city. It is proposed to run out to the Bernendo irrigated farms, Roswell Country Club, Lea Lake Club, Hagerman orchards and farms at South Springs, five miles south of Roswell.

LOS ANGELES, CAL.—R. C. Gillis, president of the Los Angeles-Pacific Railway Company, has left for New York to complete financial arrangements for the construction of a double track subway electric road to Santa Monica, Ocean Park and Venice, and the construction of terminal and office building on Hill street, between Fourth and Fifth.

SACRAMENTO, CAL.—Representatives of the Northern Electric Company have made application for a franchise on Nineteenth street from C to K streets. It is the intention of the Northern Electric to run their interurban cars from their yards at Nineteenth and C, where the road enters the city to the depot of the Western Pacific Company, located in the block bounded by Nineteenth and Twentieth, J and K streets.

SOUTH PASADENA, CAL.—The Pacific Electric Railway Company has purchased three lots on the south side of Pasadena avenue on the north slope of the hill, south of the Cawston ostrich farm. It is understood that these lots were purchased for the purpose of putting a tunnel through the hill in order to lay street railway tracks from the Pacific old line to Lincoln Park station south through the hills to connect within a short time at a point near Bairdstown. This will shorten the distance to Pasadena.

LOS ANGELES, CAL.—The Pacific Electric Company has let the contract for the extension of the Covina line from Covina to San Dimas to Robert Sherer & Co. The Ontario and San Antonio Heights line from Pomona to Uplands via Claremont has settled its right of way difficulties and construction is being rushed on this line as well. This will mean that within 30 days there will be only the seven-mile gap between San Dimas and Pomona to be connected up before the Pacific Electric will be in a position to run through cars from Long Beach to Ontario.

SACRAMENTO, CAL.—Work of ballasting the Northern Electric Roadbed from Alamos, 20 miles north of here, to Sacramento, is in progress and will be finished before the wet weather commences. A new depot has been finished on the line at Thermalito, and work is in progress on a structure at Nicolaus. The construction of a new station at Live Oak will soon be commenced. The report of the Northern Electric to the State Board of Equalization shows the gross earnings of the railroad to have been $422,642 for the fiscal year. Because of the fact that for two months in 1909 the railroad was practically out of business because of damage done by the Feather, Yuba and Bear rivers to its bridges, this amount was slightly under the amount of earnings for the year previous.

ALAMEDA, CAL.—The work of converting the local steam roads of the Southern Pacific Company into a modern electric traction system is nearing completion. Practically all of the tracklaying has been finished and nearly all of the grading is done. Crossarm trolley poles have been installed and the large feed cables placed in position. The auxiliary electric power plant on the north side of the tidal canal near the Fruitvale avenue bridge is approaching completion, and the steel framework of the car house at Alameda point is in position. The ballasting of the double track roadbed on the extension loop from Eagle avenue and Broadway around the east end of the city to the eastern end of Encinal avenue is under way. The Eighth street crosstown line, which connects the north and south side lines, is completed and the double track extension in Lincoln avenue, west from Mastick station to a point on the south side line near Pacific avenue station is finished. On the Alameda mole the trolley wires and power cable will be carried on trusses extended between heavy iron poles. The trusses are already in position. Near the depot at the pier, where a number of switches are to be used, the trolley lines will be attached to wires suspended from tall wooden poles. No definite date has yet been fixed by the Southern Pacific management for the opening of the new electric system.

TELEPHONE AND TELEGRAPH.

PORT TOWNSEND, WASH.—The Independent Telephone Company has been awarded the contract for furnishing the three forts at this place with telephone service.

ASHLAND, ORE.—The Pacific States Telephone Company has bought out the Midway Telephone Company, operating between Ashland and Klamath Falls.

PENDLETON, ORE.—The Butter Creek telephone line has been taken over by the Eastern Oregon Independent Telephone Company. A. B. Thomas has been named as manager.

GRANDVIEW, WASH.—Harry Miles of the Benton Independent Telephone Company of Prosser has secured a 25-year franchise in this city. Material has been ordered for an exchange.

KLAMATH FALLS, ORE.—The Council has passed an ordinance granting to the Pacific Telephone & Telegraph Company a franchise to place poles and wires in the streets of this city.

PORTLAND, ORE.—Contracts have been let for 650 miles of copper-clad telephone wire for the proposed telephone system of the Oregon Trunk. The proposed system will cost about $50,000.

VANCOUVER, B. C.—The Pacific Telephone & Telegraph Company has been granted permission to excavate and lay an underground conduit for a trunk line for the new subway system of telephone lines.

NEW WESTMINSTER, B. C.—The British Columbia Telephone Company proposes to make extensive improvements in its system here next year, including an addition to its building and a new switch board.

LAS CRUCES, N. M.—The Tri-State Telephone Company, which has taken over the local telephone exchange, will soon begin the erection of a new plant, also the construction of a new system throughout the town.

MYRTLE CREEK, ORE.—The Council has passed an ordinance granting to the Myrtle Creek Telephone & Telegraph Company a franchise for installing within the town of Myrtle Creek, a system of telephone and telegraph wires.

PORTLAND, ORE.—$100,000 will be expended in this city and adjacent country within the next six months by the Pacific Telephone & Telegraph Company, which recently closed the deal for the purchase of the local telephone system from H. Gates.

BAKER CITY, ORE.—The contract for the re-building of the telephone line of the Sumpter valley railroad from Baker City to Sumpter has been let to Walter Kuhn, of the telephone company, and Jack London, of the electric light company. Work is to begin within a few days.

VALLEJO, CAL.—On Inspector Hanscom's return to Mare Island which will be some time in the fall, he will supervise the erection of a 300-foot wireless tower at the Mare Island yard and the installation of one of the most powerful wireless outfits that the Navy Department can manufacture.

SEATTLE, WASH.—C. H. Gaunt, general superintendent of the Pacific division of the Western Union Telegraph Company, announces that his company will build a new telegraph line from Seattle to Helena, Mont. Material for this line is now being assembled. Gaunt also made public the appointment of Edward Boening, formerly attached to the superintendent's office in San Francisco, to take charge of the Seattle office, succeeding District Superintendent R. T. Reid, whose resignation has already been presented.

SAN FRANCISCO, CAL.—The Home Telephone Companies of San Francisco and of Alameda counties, which have been operated under a common management, were announced recently to have merged their interests into the Bay Cities Home Telephone Company. The consolidation necessitated the taking up of the bond issues of the former two companies and the issuance of $20,000,000 of new securities. Attorney Frick says: "The mortgages held by the Union Trust Company on the properties of the local Home Company and by the Mercantile Trust Company on those of the Alameda company have been taken up and the Angle-California Trust Company has assumed the trusteeship of the new corporation and will underwrite a $20,000,000 bond issure retiring the others."

WATERWORKS.

RIVERSIDE, WASH.—F. J. Cummings will improve the streets and install a water system on Glenwood acre tracts this fall.

VALE, ORE.—The City Council has awarded to the American Light & Water Company the contract for the Vale water system. Engineer Bullock will have charge of the work.

TACOMA, WASH.—The Council has passed an ordinance providing for the construction of water mains in portions of Pacific avenue, South Fortieth street, South G street, Division lane, being Local Improvement District No. 558, the pipe ranging in size from 6 to 12 inches.

FALLON, NEV.—The City Council passed an ordinance authorizing the establishment, building and constructing a waterworks system for domestic use, manufacturing and fire protection for said city, to borrow the sum of $35,000 for this purpose and to issue and sell bonds of said city therefor.

ALAMEDA, CAL.—The negotiations between this city and the Bay Cities Water Company progressed another step July 25, when the acting city physician, H. A. Miller, reported that the analysis of samples of Bay Cities' water, made by the City Chemist, Miss Jessie Berry, showed that the water is good for all domestic purposes.

NEWARK, CAL.—For the last few days surveyors of the Bay Cities Water Company have been running a line through the Pacific Land Improvement Company's property near this place. Surveys have been made along the principal thoroughfares of Newark, and it is believed the new company plans to supply water to the residents of this district.

SAN FRANCISCO, CAL.—City Engineer Manson has filed a recommendation with the Board of Public Works that $3,000,000 of municipal water supply bonds be offered for sale, delivery to be made during the next two years, in order to provide funds for work. The amount of money named will, he states, enable the municipality to accomplish the following things: "To take up all, or an agreed portion, of the option on the Cherry Creek lands and rights; to construct the Lake Eleanor dam and canal; to construct the North Mountain power station, and to utilize the power therefore for construction and municipal purposes; to sell the water during the dry season under the terms of the grant of May 11, 1908, until the construction of conduits to the city." Regarding the Spring Valley property the city engineer says: "We are advised that extensive purchases of lands and rights in Livermore valley and of lands adjacent to the Sunol filter beds and the acquisition of the final rights in the Alameda creek drainage basin have been accomplished by the Spring Valley Company since the election of January 14, 1910. These acquisitions cover about 14,200 acres and have removed the possibility of litigation then under way or in prospect, and have involved an expenditure of about $1,700,000. More thorough explorations for the foundation for Calaveras dam are being made with a view of its early construction. The use of the water so stored is not definitely announced, but without an adequate increase in conduit capacity it would not be available to this city.

INDEX TO ADVERTISEMENTS

A

Allis-Chalmers Co.
Milwaukee, Wis.
San Francisco, Jackson Bldg. 2nd and Natoma.
Los Angeles, 129-131 E. Fifth.
Portland, 92 First.
Seattle, 115 Jackson.

Aluminum Co. of America ... 4
Pittsburgh, Pa.
San Francisco, Monadnock Bldg.
Los Angeles, Pacific Electric Bldg.
Seattle, Colman Bldg.

American Circular Loom Co. ... 17
Boston, 45 Milk.
San Francisco, 770 Folsom.
Seattle, 416 American Bank Building.

American Electrical Heater Co. ... 11
Detroit, U. S. A.

Aylsworth Agencies Co.
San Francisco, 165 Second.

B

Benjamin Electric Mfg. Co. ... 2
New York, 27 Thames.
Chicago, 120-128 S. Sangamon.
San Francisco, 151 New Montgomery.

Blake Signal and Mfg. Co. ... 4
Boston, 246 Summer.

Bonestell & Co. ... 12
San Francisco, 118 First.

Brookfield Glass Co., The ... 1
New York, U. S. Exp. Bldg.

Buxbaum & Cooley
Seattle, 69 Columbia St.

C

Cal. Incandescent Lamp Co. ... 12
San Francisco, 633 Howard.

Century Electric Co. ... 18
San Francisco, 633 Howard.

D

D. & W. Fuse Co. ... 14
Providence, R. I.

Davis, R. J. ... 18
San Francisco, 633 Howard.

Dearborn Drug & Chem. Works ... 12
Chicago, Postal Bldg.
San Francisco, 301 Front.
Los Angeles, 355 E. 2d.

Duncan Elec. Mfg. Co. ... 11
Lafayette, Indiana.
San Francisco, 61 Second.

E

Electric Goods Mfg. Co.
Boston, Mass.
San Francisco, 165 Second.

Electric Storage Battery Co. ... 5
Philadelphia, Pa.
San Francisco, Monadnock Bldg.

F

Fort Wayne Electric Works
Fort Wayne, Ind.
San Francisco, 604 Mission.
Seattle, Colman Bldg.

G

General Electric Co. ... 16
Schenectady, N. Y.
San Francisco, Union Trust Bldg.
Los Angeles, Delta Bldg.
Seattle, Colman Bldg.
Portland, Worcester Bldg.
Atlanta, Ga.
Baltimore, Md.
Boston, Mass.
Buffalo, N. Y.
Butte, Mont.
Charleston, W. Va.
Charlotte, N. C.
Chicago, Ill.
Cincinnati, O.
Cleveland, O.
Columbus, O.
Denver, Colo.
Detroit, Mich.
Indianapolis, Ind.
Kansas City, Mo.
Minneapolis, Minn.
Nashville, Tenn.
New Haven, Conn.
New Orleans, La.
New York, N. Y.
Philadelphia, Pa.
Pittsburg, Pa.
Richmond, Va.
Salt Lake City, Utah.
St. Louis, Mo.
Spokane, Wash.
Syracuse, N. Y.

Goeriz, O. C. & Co. ... 14
San Francisco, 916 Postal Tel. Bldg.

H

Habirshaw Wire Co. ... 15
New York, 253 Broadway.

Henshaw, Bulkley & Co. ... 1
San Francisco, 19 Fremont.
Oakland, 1436 5th.
Los Angeles, 262 S. Los Angeles.

Hitchcock Military Academy, The ... 13
San Rafael, California.

Holtzer-Cabot Elec. Co., The ... 3
Boston and Chicago.
San Francisco, 612 Howard.

Hughes & Co., E. C. ... 11
San Francisco, 147-151 Minna.

Hunt, Mirk & Co. ... 6
San Francisco, 141 Second.

I

Indiana Rubber & Ins. Wire Co. ... 1
Jonesboro, Indiana.

J

Johns-Manville Co., H. W. ...
New York, 100 William.
San Francisco, 159 New Montgomery.
Los Angeles, 203 E. 5th.
Seattle, 576 1st Ave. So.

K

Kellogg Switchb'd & Supply Co.
Chicago.
San Francisco, 88 First.

Kierulff, B. F. Jr. & Co.
Los Angeles, 120 S. Los Angeles.

Kiewert, Chas. L. Co.
San Francisco, 195-7 Fremont.
Los Angeles, 225 Franklin Court.

Kilbourne & Clark Company ...
Seattle, 307 First Ave. So.

L

Lindsley-Wright Co. ... 5
Portland, Ore., 336 Sherlock Bldg.

Locke Insulator Mfg. Co. ...
Victor, N. Y.
San Francisco, Monadnock Bldg.
Los Angeles, Pacific Electrical Bldg.
Seattle, Colman Bldg.

M

Moore, Chas. C. & Co. Engineers. 3
San Francisco, 99 First.
Los Angeles, American Bank Bldg.
Seattle, Mutual Life Bldg.
Portland, Wells-Fargo Bldg.
Salt Lake City, Atlas Blk.
New York City, Fulton Bldg.

N

New York Insl'td Wire Co. ... 4
New York, 114 Liberty.
San Francisco, 770 Folsom.
Seattle, 416 American Bank Bldg.

Northwestern Pacific Railroad ... 18
San Francisco, 874 Market.

O

Ohio Brass Co. ... 5
Mansfield, Ohio.
San Francisco, Monadnock Bldg.
Los Angeles, Pac. Electric Bldg.
Seattle, Colman Bldg.

Okonite Co. ... 1
New York, 253 Broadway.

P

Pacific Electric & Mfg. Co. ... 14
San Francisco, 80 Tehama.

Pacific Gas & Elect. Co., The ... 13
San Francisco.

Pacific Meter Co. ... 1
San Francisco, 311 Santa Marina Bldg.

Pacific States Electric Co. ... 17
San Francisco, 137 New Montgomery Street

Pacific Tel. & Tel. Co., The ...
San Francisco.

Partrick Carter & Wilkins Co. ...
Philadelphia, 22d and Wood

Pelton Water Wheel Co., The ... 11
San Francisco, 1095 Monadnock Bldg.

Phillips Insulated Wire Co. ... 1
Pawtucket, R. I.

Pierson, Roeding & Co. ... 4
San Francisco, Monadnock Bldg.
Los Angeles, Pac. Electric Bldg.
Seattle, Colman Bldg.

Portland Wood Pipe Co. ... 11
Portland, Ore.

R

Reisinger, Hugo ... 11
New York, 11 Broadway.

S

Schaw-Batcher Co. Pipe Works ... 11
Sacramento, Cal., 311 J St.
San Francisco, 256 Market.

Simplex Elect'l Co., The ... 3
Boston, 110 State.
San Francisco, 612 Howard.
Los Angeles, Security Bldg.
Seattle, Alaska Bldg.
Portland, Couch Bldg.

Simplex Electric Heating Co. ...
Cambridge, Mass.
San Francisco, 612 Howard.
Los Angeles, Security Bldg.
Seattle, Alaska Bldg.
Portland, Couch Bldg.

Southern Pacific Co. ... 18
San Francisco, Flood Bldg.

Sprague Electric Co. ... 13
New York City, 527-531 W. 34th.
San Francisco, Atlas Bldg.
Seattle, Colman Bldg.

Standard Und. Cable Co. ... 1
San Francisco, First National Bank Bldg.
Los Angeles, Union Trust Bldg.
Seattle Office, Lowman Bldg.

Star Expansion Bolt Co. ...
New York City, 147-149 Cedar.

Sterling Paint Company, ... 12
San Francisco, 118 First.

T

Technical Book Shop ... 16
San Francisco, 604 Mission.

Tel. & Elec. Equip. Co. ... 3
San Francisco, 612 Howard.
Los Angeles, Security Bdg.
Seattle, Alaska Bldg.
Portland, Couch Bldg.

Thomas and Sons Co., R. ... 15
New York, 227 Fulton.
East Liverpool, Ohio.

Tracy Engineering Co. ... 11
San Francisco, 461 Market.
Los Angeles, Central Bldg.

V

Vulcan Iron Works ... 1
San Francisco, 604 Mission.

W

Western Electric Co. ... 4
San Francisco, 680 Folsom.
Oakland, 507 16th.
Los Angeles, 119 E. 7th
Seattle, 1518 First Ave. So.

Western Wireless Equipment Co. ... 14
San Francisco, Grant Bldg, 7th and Market.

Westinghouse. Elec. & Mfg. Co. ... 6
Pittsburg, Pa.
Los Angeles, 527 So. Main.
Denver, 429 17th.
Seattle, Central Bldg.
Salt Lake City, 212-214 So. W. Temple.
San Francisco, 165 2d.
Spokane, Columbia Bldg.
Portland, Couch Bldg.
Butte, Lewisohn Bldg.
Canada, Canadian-Westinghouse Co., Ltd., Hamilton, Ontario.
Mexico, G. & O., Braniff & Co., City of Mexico.

Westinghouse Machine Co. ... 6
Pittsburg, Pa.
San Francisco, 141 Second.

Weston Elect'l. Instrument Co. ... 18
Waverly Park, N. J.
New York, 114 Liberty.
San Francisco, 682-684 Mission.

Wilbur, G. A. ... 11
San Francisco, 61 Second.

Witt Company, G. E., Inc. ...
San Francisco, 850 Howard.